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# High Temperature Borehole Televiewer Software User Manual

Leonard E. Duda

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**Sandia National Laboratories**
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# HIGH TEMPERATURE BOREHOLE TELEVIEWER SOFTWARE USER MANUAL

Leonard E. Duda
Geothermal Research Division
Sandia National Laboratories
Albuquerque, NM 87185

## ABSTRACT

The **High Temperature Borehole Televiewer** is a downhole instrument which provides acoustic pictures of the borehole walls that are suitable for casing inspection and fracture detection in geothermal wells. The Geothermal Drilling Organization has funded the development of a commercial tool survivable to temperatures of 275°C and pressures of 5000 psi. A real-time display on an IBM-compatible PC was included as part of the development effort. This report contains a User Manual which describes the operation of this software. The software is designed in a menu format allowing the user to change many of the parameters which control both the acquisition and the display of the televiewer data. An internal data acquisition card digitizes the waveform from the tool at a rate of 100,000 samples per second. The data from the tool, both the range or arrival time and the amplitude of the return signal, are displayed in color on the CRT screen of the computer during the logging operation. This data may be stored on the hard disk for later display and analysis. The software incorporates many features which aid in the setup of the tool for proper operation. These features include displaying and storing the captured waveform data to check the voltage and time windows selected by the user. The report provides the detail of the important data acquisition and display operations performed by the software. The results of two field tests of the televiewer system are described. Some of the more interesting data from the field tests are discussed. Finally, the report concludes with a list of suggested improvements or modifications to the software and hardware.

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# I. INTRODUCTION

The acoustic borehole televiewer (BHTV) is a downhole logging tool which uses a beam of ultrasonic energy from a rotating transducer to produce an acoustic picture of the inside circumference of a wellbore. Since its introduction in 1968, considerable effort has been made to interpret and improve the images of the borehole that are obtained from this tool [1, 2, 3]. The televiewer has been used for fracture detection, casing inspection, and for checking the integrity of casing-cement seals. The data from this tool is typically displayed in two forms. The received amplitude or magnitude of the reflected signal can be displayed to show the reflectivity of the borehole wall. Alternatively, the arrival or transit time of the received signal can be displayed to provide an estimate of the range, in time, or the size, in radius if the sound velocity of the borehole fluid is known. In 1983, researchers at Sandia National Laboratories completed the modifications to a commercially available tool extending its operational range to a temperature of 275°C and a pressure of 5000 psi for use in a geothermal environment [4]. The tool modifications included the development of a rotating head transformer, a high temperature transducer, and a redesign of the electronics for high temperature operation.

The Geothermal Drilling Organization jointly funds projects of interest to the geothermal industry using DOE and industry funds [5]. One of these projects was the development of a high temperature borehole televiewer using the modifications from the Sandia BHTV project and incorporating a real-time computer display of the data received from the tool. This report is the user manual for the software developed for the GDO-sponsored borehole televiewer. This software was developed with the goal of providing as simple an environment as possible but still retaining the flexibility of allowing the user to control as many parameters as desired. This software acquires, displays and stores the data obtained from the televiewer in real time - that is, as the tool is logging the borehole.

The software was written in Turbo Pascal Version 4.0 specifically for a Compaq Deskpro 386/20 computer. Data from the tool is digitized using a Metrabyte DAS-20 data acquisition card at a digitizing rate of 100,000 samples/s. Depth information is obtained from a Red Lion Gemini 2000 counter via a RS-232 serial interface using a baud rate of 2400. The High Temperature Borehole Televiewer (HT-BHTV) may use either a magnetometer or an internal tool mark pulse as a heading reference for the data from the tool. The tool also has two transducers, one at 1.3 MHz and another at 400 kHz, for high and low resolution details. The software allows the user to select the heading reference, transducer frequency, and the gain of the tool. In addition, three temperatures from the tool may be monitored via a 300 baud RS-232 serial line. These temperatures include two internal temperatures which monitor the condition of the heat-shield encased electronics and an external borehole fluid temperature. The software allows the user to monitor the data from the tool during the logging operation and to display the stored data for later analysis.

The digitized range and amplitude data obtained from the HT-BHTV tool are displayed on the CRT screen as a single horizontal line. This line represents a single rotation of the tool. The data line provides an unfolded view of the inside diameter of the borehole. The leftmost position of the display indicates the position of the mark pulse or magnetic north when the magnetometer is used. The range data shown on the display are the round-trip distances of the returned signal in units of microseconds. If the sound velocity in the fluid is known, the diameter of the borehole may be estimated from the time of the return signal.

## I.1. Organization of the User Manual

This manual is organized into several sections allowing the user a rapid reference for information pertaining to the software operation. Section II describes the operation of the software. Each of the menus is discussed in detail explaining the various options allowed by the software. At first glance, the number of options allowed in the software appears to make the operation of the tool by the software very difficult. However, the software was designed to allow the user to control many of its parameters. With a little understanding of the capabilities of both the software and the HT-BHTV tool, the user will quickly discover the usefulness of this software approach. Also described in Section II is the screen display of the data obtained from the tool. Section II concludes with a short discussion of data backup and briefly describes a temperature acquisition program that can be used to acquire tool temperatures during a logging operation. Because of the limitations involved with the high speed data acquisition/display process and the low speed communication over the serial interface line with the tool, this version of the software cannot simultaneously acquire acoustic and temperature data from the tool using a single computer. A second computer system (any IBM PC compatible system can be used) is required for the temperature acquisition. Section III provides more detail on certain aspects of the software operation. It describes the communication procedure with the tool and the depth counter. The format of the files used for data storage is described. More detail is provided about the data acquisition using the digitizing board and the processing performed on the tool data before its display on the CRT screen. Finally, some discussion is given concerning the color printing of the CRT screen. Section IV summarizes the results of two field tests which were used to test the tool and software under actual logging conditions. Some data is presented illustrating the capabilities of the HT-BHTV system to detect wellbore features. Section V concludes the user manual with a brief discussion of possible improvements that can be made in both the software and the computer-related hardware. An appendix is included providing a description of the hardware requirements of the computer system.

## II. OPERATION OF THE BHTV SOFTWARE

The software for the High Temperature Borehole Televiewer (HT-BHTV) is written in a menu-driven format which allows ease of use and provides a flexible operation for the user. In this section, the capabilities of each menu are explained, the information displayed on the CRT screen when the data is being acquired and/or displayed is discussed, and the section concludes with a brief discussion of data storage on tape and temperature acquisition from the tool.

### II.1. Starting the HT-BHTV program

The HT-BHTV software is designed so that the user requires little knowledge of the program file structure for the correct operation of the software. A complete description of the file structure used in the software may be found in Section III of this manual. Briefly, the data stored by this program is contained in the directory labeled BHTVDATA. The program requires two text files (containing the extension .TXT) in the directory containing the main program. These files are labeled VDISK.TXT and BHTVPATH.TXT. The former file contains the path name for the virtual RAM disk drive which temporarily stores the data obtained from the tool. The latter file contains the path name for the hard disk drive containing the BHTVDATA directory which contains all the data from the tool. Note also that no TSR (terminate stay resident) programs (for example, Sidekick) should be present on the system.

The computer system has an internal Analog-to-Digital Converter (ADC) card installed in one of the available slots. This card digitizes the waveform data from the HT-BHTV tool (see Section III for a further discussion of the data acquisition process and Appendix A for the hardware requirements of the system). This digitized data are used by the software to find the range and magnitude values of the data according to certain user-supplied threshold values and time windows. Because of an unknown memory conflict when this board is used, the user must first, in effect, initialize the system with this board before any data can be obtained from the tool. If this prior initialization is not performed, the computer will lock up requiring either a cold or warm boot (these are described later in this section) to restart. If the ADC card will not be used, this initialization procedure is not necessary. The initialization procedure is begun by typing at the C> prompt:

```
C> BHTVINIT
```

The first time, the system will display the screen for the Data Acquisition Test from the Data Acquisition Menu (refer to Section II.5.4). However, the test may fail this first time. Typing the above command again should produce a working display if the HT-BHTV is working and properly connected. If a working display is obtained, the system has been properly initialized and the HT-BHTV software may be started by pressing any key.

To start the HT-BHTV program without initializing the ADC board, type in the following followed by a return at the C> prompt:

C> HTBHTV

This command calls a batch file of the same name which sets the computer into the proper directory and the starts the HT-BHTV program contained in the file BHTVMAIN.EXE. This procedure is used when the ADC board will not be used in the software operation. For example, when only stored data will be displayed. This procedure is also used for displaying stored data when the ADC board is not present on the computer system.

If a failure occurs in the software, two things will happen. The computer will exit the software and return to the operating system. The software may simply be restarted as shown above. If, however, the software fails to respond in either a menu or the data display operation then the user must first press Ctl-C or Ctl-Break. If pressing these keys result in exiting the software, then the program can be restarted. If these keys produce no response, then either a warm or cold boot of the system is required. A warm boot is accomplished by resetting the computer by pressing Ctl-Alt-Del. If there is no response, then it is necessary for a cold boot of the system. Turn the computer off, wait a few seconds, and turn the computer on. The HT-BHTV software may then be started using the procedure described above.

## II.2. Connection of Input/Output devices

The HT-BHTV software requires several Input/Output (I/O) devices for the acquisition of the tool and depth data. The complete hardware requirements of the system are listed in Appendix A. Table II.2 summarizes the devices and the connections to the computer.

Table II.2. Devices connected to HT-BHTV computer system.

| Computer port | Device |
|---|---|
| COM1 | Serial converter for Depth Counter |
| COM2 | Serial I/O of HT-BHTV Tool |
| LPT1 | Color printer (parallel interface) |

## II.3. User-Controlled Software Flags

There are three software flags that are controlled by the user. These three flags are the Tool Flag, the Depth Flag, and the Temperature Flag. Each flag is a boolean-type variable having a value of either True or False. The flags are accessed by the Test Parameter/Setup File Menu. When the Tool Flag is set to True, the software will expect the HT-BHTV tool to be connected and operating. When data acquisition and display is selected, the program will attempt to acquire data from the HT-BHTV tool. (WARNING: If the tool is not connected and operating and the Tool Flag is set to True, it is possible to lock up the computer so that either a warm or cold boot is required for computer restart.) If the Tool Flag is set to False, the software will not attempt to access the tool and will display simulated data if that is the function selected. The Depth Flag controls access to the depth counter system. When set to True, the depth counter system must be connected and activated. In this setting the program will acquire the depth information from the counter when required. When set to False, the software will simulate depth data when required by the program operation. The Temperature Flag is used for the acquisition of temperature data from the HT-BHTV tool. It is used in conjunction with the Tool Flag to specify to the software where to obtain the temperature data. If both the Tool Flag and the Temperature Flag are True, the temperature data will be obtained from the HT-BHTV tool. If the Tool Flag is set to False and the Temperature Flag is set to True, the program will simulate the temperature data. If the Temperature Flag is False, no temperature data will be acquired or displayed.

## II.4. Modes of Operation of the Software

The software has three modes of operation which direct it for the proper acquisition, storage, or retrieval of data. These three modes are called the TEST, BHTV, and FILE mode. The current mode value is stored in the Data Mode variable and is selected from the Logging Setup menu which will be described in more detail later in this section. In the TEST and the BHTV mode, the setting of the Tool Flag directs the software to either acquire data from the HT-BHTV tool or to compute simulated data. The TEST mode displays the data from the tool or the simulated data. The BHTV mode displays the data as in the TEST mode but, in addition, the data is stored in the file designated previously in the File Menu. The FILE mode is used to retrieve and display data previously stored to the hard disk. The setting of the Tool Flag is unimportant to the operation of this mode. If the File Display Menu is called and a file has been opened in the BHTV File Menu, then the software automatically sets the operational mode to FILE. Table II.3 in Section II.6 on the Data Acquisition and Display operation of this software summarizes the possible settings of the flag and Data Mode variables.

## II.5. Menu Descriptions

The software consists of a set of eight menus divided according to their function. Table II.2 lists these eight menus. The function and operation of each of these menus will be discussed.

Table II.2. List of the menus available in the HT-BHTV software.

| |
|---|
| Main Menu |
| Depth Encoder Setup Menu |
| Tool Setup Menu |
| Data Acquisition Menu |
| Logging/Data Display Setup Menu |
| BHTV File Menu |
| File Display Menu |
| Test Parameter/Setup File Menu |

In the next part of this section, the operation of each menu is described. Figure II.1 gives a block diagram of each of these menus including the Data Acquisition/Display unit of the software.

### II.5.1. Main Menu

The Main Menu is the menu displayed when the software is started and provides the link to all the other menus available in the software. The menu displayed on the CRT screen is shown in Figure II.2. All except the Data Acquisition/Display selection call up another menu. As shown in Figure II.1, the Data Acquisition Menu can only be accessed through the Tool Setup Menu. This was done in this manner because the function of the Data Acquisition Menu is to set up the parameters of the ADC and to test the data acquisition from the tool. The Data Acquisition/Display selection is, of course the major function of this software. Its operation will be described following the description of the other menus. In this and all other menus in the software, the user may move among the items in the menu using the up or down arrow keys or by using a number key if the items have a number. The current item is highlighted and may be selected by pressing the return key. The items shown in the Main Menu CRT screen display in Figure II.2 will be briefly described.

Menu Item: 1) Setup/Initialize BHTV Tool
Function: Enters the Tool Setup Menu which permits the user to modify the various tool parameters. Also, the Data Acquisition Menu is accessed from this item.

Menu Item: **2) Setup/Check Depth Encoder System**
Function: Enters the **Depth Encoder Setup Menu** from which the operation of the depth counter system can be checked.

Menu Item: **3) Set Logging Parameters**
Function: Enters the **Logging/Data Display Setup Menu**. This menu allows the user to change many parameters affecting the display of the televiewer data on the CRT screen.

Menu Item: **4) Set Up Files for Data Storage**
Function: Enters the **BHTV File Menu** which selects the file for display or data storage. In addition, pertinent information about the hard disk on the computer is displayed.

Menu Item: **5) Begin Data Acquisition and Display**
Function: Selecting this item directs the software to begin the acquisition and/or display of televiewer data. The operations actually performed here depend on the conditions specified by the user in the eight menus in the HT-BHTV software.

Menu Item: **6) Display Stored Data**
Function: Enters the File Display Menu which allows the user to select a portion of a data file to display. Either a depth or a record number interval may be selected.

Menu Item: **7) Display/Modify Test Parameters**
Function: Enters the **Test Parameter/Setup File Menu**. This menu sets the user-controlled software flags and also allows the user to store or read a previously stored file containing certain software parameters.

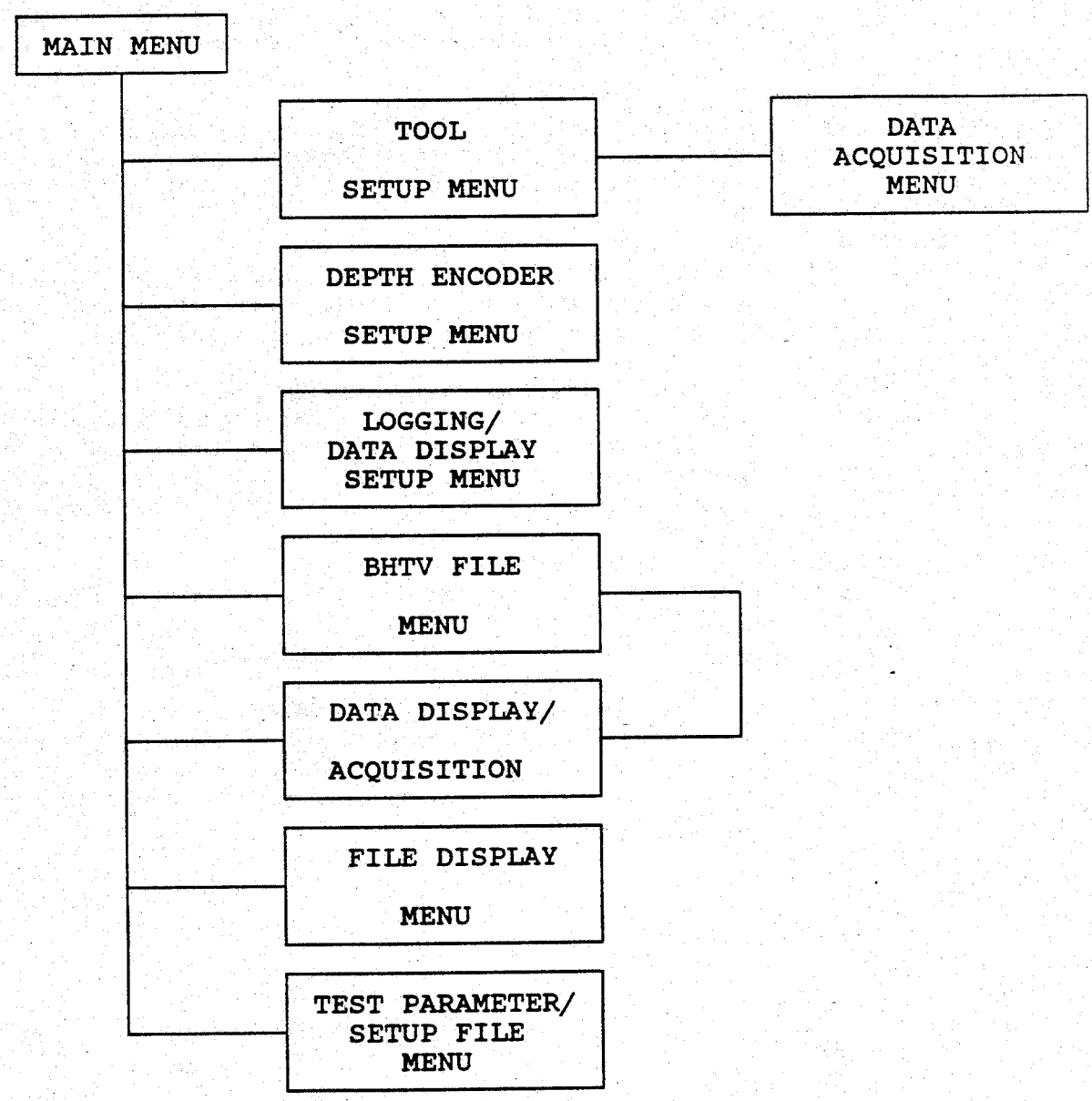


Figure II.1. Diagram of the menus in the HT-BHTV software. Note that the Data Acquisition Menu is accessed only from the Tool Setup Menu. The Data Display/Acquisition section is not a menu but it performs all the operations previously set in the other menus.

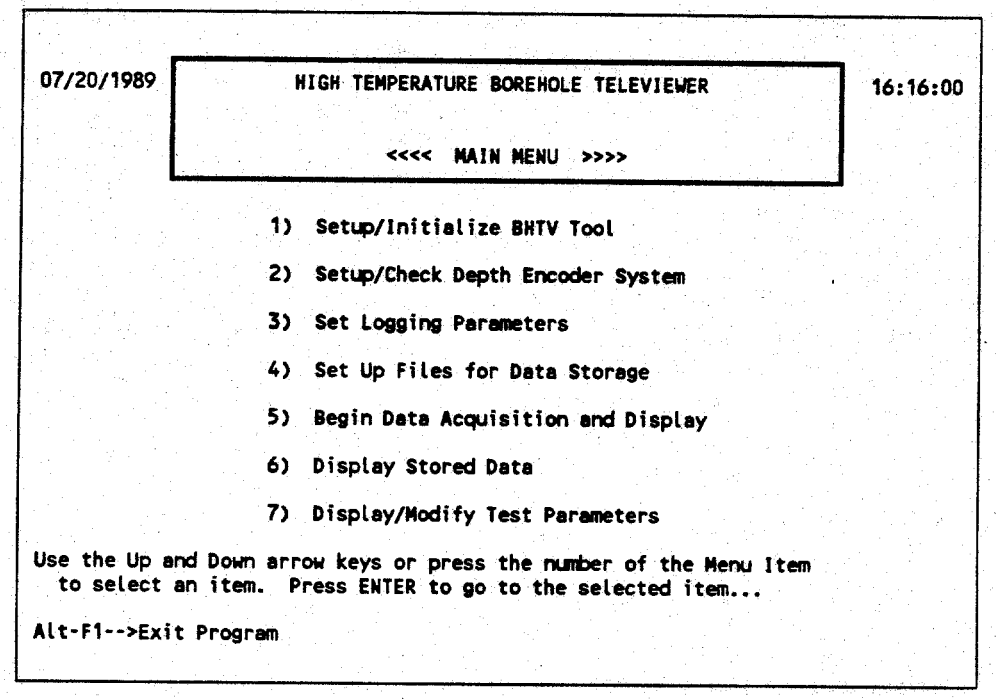


Figure II.2. CRT screen display for the Main Menu. This display illustrates the format used in the other menus. Each menu has a header which gives the menu name. On either side of the menu the current machine date and time are displayed. (Note: If either the date or time displayed in the menus is incorrect, the user should exit the program, returning to the operating system, and correct them. The machine date and time are stored in the data files during the data acquisition process.) Below the header is a list of menu selections. The current menu selection, which can be activated by pressing the Enter key, is shown highlighted. On some menus, an item selection message is displayed below the list of menu selections. Finally, the function key (or keys) that, when pressed, exit the menu, end the program, or perform some other operation are displayed at the bottom of the screen.

## II.5.2. Depth Encoder Setup Menu

The CRT screen display for the Depth Encoder Menu is shown in Figure II.3. The purpose of this menu is to setup and test the depth counter connected to the computer using the serial port COM1. The counter itself is a Gemini 2000 model which is connected to an optical encoder mechanically attached to the cable or the cable drum assembly. The counter has a nonvolatile memory which stores the last values of the Preset and Scale Factor. When the Depth Flag is True, the software interrogates the counter for the Preset and Scale Factor values. If the counter does not respond, the first error message shown in the error message section is displayed. The current menu item is highlighted and may be selected by pressing the Return or Enter key. To move between the menu items, the user may either select the number of the desired item or move between the items by using the up or down arrow keys. As shown in the example in Figure II.3, each menu item has a short descriptive message explaining the function of the highlighted menu selection. The functions of the four menu items in this menu are described below:

| | |
|---|---|
| Menu Item: | **Reset Counter** |
| Default Value: | Not Applicable |
| Other Values: | Not Applicable |
| Function: | Resets the counter to the preset value stored in the counter. |
| Menu Item: | **Scale Factor** |
| Default Value: | If Tool Flag is True then the scale factor stored in the counter is displayed. If False, a value of 1.0000 is displayed. |
| Other Values: | Allowed Range:<br>$-5.9999 \leq$ Scale Factor $\leq +5.9999$ |
| Function: | When Tool Flag is True, this item displays the current scale factor stored in the counter. Pressing the ENTER key allows the user to store a new scale factor in the counter. When the new factor has been entered in the counter, the counter display will change according to the new factor. The counter should be reset to the previously stored preset value. |
| Menu Item: | **Preset Value** |
| Default Value: | If Tool Flag is True then the preset value stored in the counter is displayed. If False, a value of 0.00 is displayed. |
| Other Values: | Allowed range:<br>$-9999.99 \leq$ Preset Value $\leq +9999.99$<br>(when the counter is set to display 2 decimal places). |
| Function: | When Tool Flag is True, this item displays the current preset value stored in the counter. Pressing the ENTER key allows the user to store a new preset value |

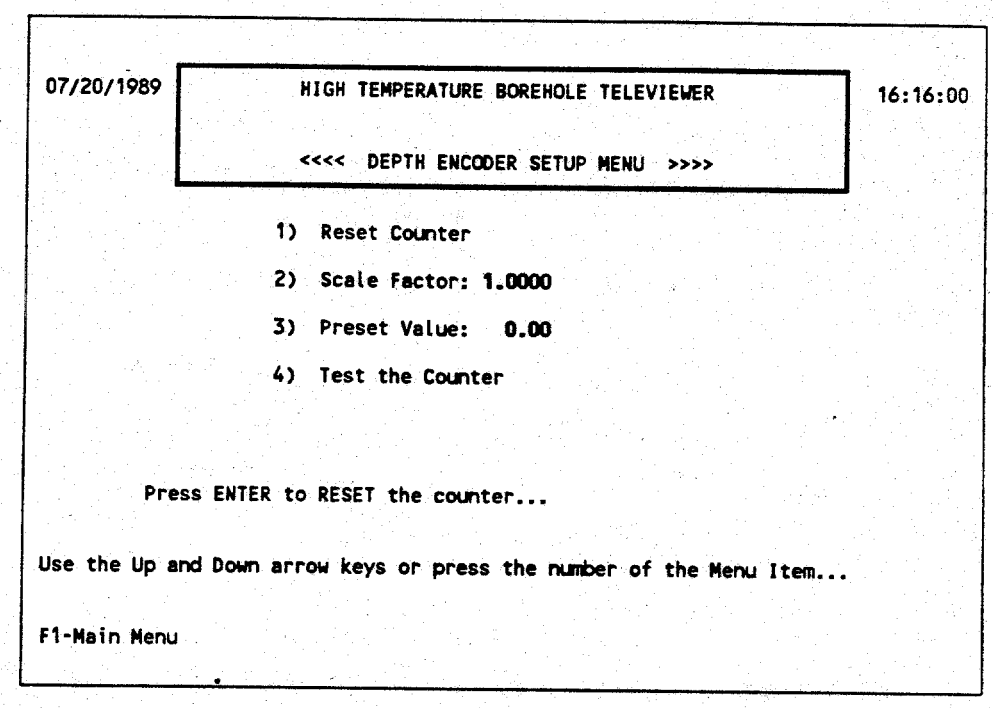


Figure II.3. Example of the default CRT screen display for the Depth Encoder Setup Menu shown when the Depth Flag variable is False.

in the counter. Resetting the counter sets the counter display to the new preset value.

| | |
|---|---|
| Menu Item: | **Test the Counter** |
| Default Value: | Not Applicable |
| Other Values: | Not Applicable |
| Function: | Tests the acquisition of the depth value from the counter. If the counter is not turned on or is improperly functioning or a problem exists with the serial interface or connections, the computer will hang up without displaying any data. The program must be exited by using a warm boot and restarted. |
| Function key: | **F1**<br>Pressing this key returns the program to the Main Menu. |

### II.5.2.1 Error Messages

In this menu, the software allows the user to enter new values for the Preset value and the Scale Factor. If the Depth Flag is False, no data entry is permitted. All error messages are displayed in the data entry window for a few seconds after which the software returns to the menu. The user must select the item again and properly enter the desired value. With the Depth Flag set to True and the counter turned on and connected to the computer, the following error messages may be displayed after the user has entered a change in one of the values:

| | |
|---|---|
| Error Message: | **Depth Counter not responding on Serial port!** |
| Problem: | No response was obtained from the depth counter when the **Depth Flag** is True. The counter was not turned on, connected to the wrong port, or some other problem may exist. The software changes the value of the **Depth Flag** to False. |
| Error Message: | **Error in the input data...** |
| Menu Item: | All data input selections. |
| Problem: | Incorrect data entry; for example, a letter rather than a numeral value may have been entered. |
| Error Message: | **Scale Factor outside of range: -5.9999 <= Factor <= 5.9999** |
| Menu Item: | Scale Factor |
| Problem: | The value entered is outside the allowed range of the Scale Factor for the counter. |
| Error Message: | **Scale Factor not entered into counter...** |
| Menu Item: | Scale Factor |
| Problem: | A timeout has occurred in checking that the new Scale Factor value was received by the counter. Previous experience has shown that the counter has indeed received the new Scale Factor but a problem occurred sending this data back to the computer. |
| Error Message: | **Preset Value outside of range: -10,000 < Value < 10,000** |
| Menu Item: | Preset Value |
| Problem: | The value entered is outside the allowed range of the Preset value for the counter. |
| Error Message: | **Preset Value Factor not entered into counter...** |
| Menu Item: | Preset Value |
| Problem: | A timeout has occurred in checking that the new Preset Value was received by the counter. Previous experience has shown that the counter has indeed received the new Preset value but a problem occurred sending this data back to the computer. |

### II.5.3. Tool Setup Menu

The CRT screen displayed for the Tool Setup Menu is shown in Figure II.4. This menu sets up the tool parameters (i.e., the gain, transducer frequency, and the heading reference) and checks the temperature acquisition from the tool. The Data Acquisition Menu, which is called from the Tool Setup Menu, sets the ADC and software parameters for data acquisition from the tool and tests this data acquisition. The current menu item is highlighted and may be selected by pressing the Return or Enter key. To move between the menu items, the user may either select the number of the desired item or move between the items by using the up or down arrow keys. As shown in the example in Figure II.4, each menu item has a short descriptive message explaining the function of the highlighted menu selection. The following parameters can be changed in this menu:

| | |
|---|---|
| Menu Item: | **Tool Gain** |
| Default Value: | x1 |
| Other Values: | x10, x50 |
| Function: | Sets the tool gain to the value displayed. |
| Menu Item: | **Transducer Frequency** |
| Default Value: | High (1.3 MHz crystal) |
| Other Values: | Low (400 kHz crystal) |
| Function: | Sets the transducer frequency to the value displayed. The HT-BHTV tool has two transducers available for use. The **HIGH** setting selects the higher frequency transducer having a frequency of 1.3 MHz. This transducer frequency is the preferred setting since the higher frequency provides more resolution allowing observation of finer details on the walls of the borehole. The **LOW** setting, a frequency of 400 kHz, provides a low resolution view of the borehole. |
| Menu Item: | **Heading Reference** |
| Default Value: | Mark |
| Other Values: | Magnetometer |
| Function: | Sets the Heading Reference to the value displayed. A value of Mark selects the internal tool mark. This is typically used when the tool is used inside casing or if the formation contains a high percentage of magnetic material. The Magnetometer setting uses the internal magnetometer so that the display may be referenced to magnetic north. |

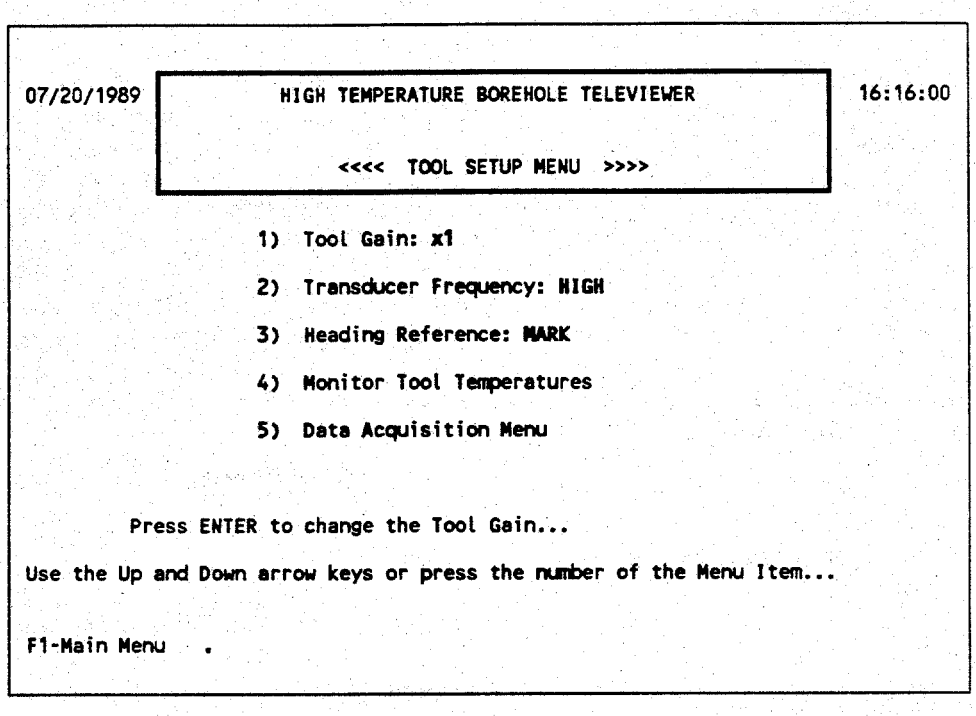


Figure II.4. An example of the CRT screen display for the Tool Setup Menu showing the default settings of the HT-BHTV tool parameters.

| | |
|---|---|
| Menu Item: | **Monitor Tool Temperatures** |
| Default Value: | Not Applicable |
| Other Values: | Not Applicable |
| Function: | This item checks the serial connection to the tool and the temperature sensors in the tool by monitoring the available temperatures. Three temperatures are returned by the tool. These are the heat sink, electronics, and the well temperature. An example of the CRT display shown while the tool temperatures are monitored is provided in Figure II.5. The heat sink and electronics temperatures monitor the internal tool temperature. The electronics in the tool has a maximum temperature limit of 150°C. The well temperature gives the temperature of the well fluid surrounding the tool. The mechanical section of the tool has a maximum temperature limit of 275°C. |

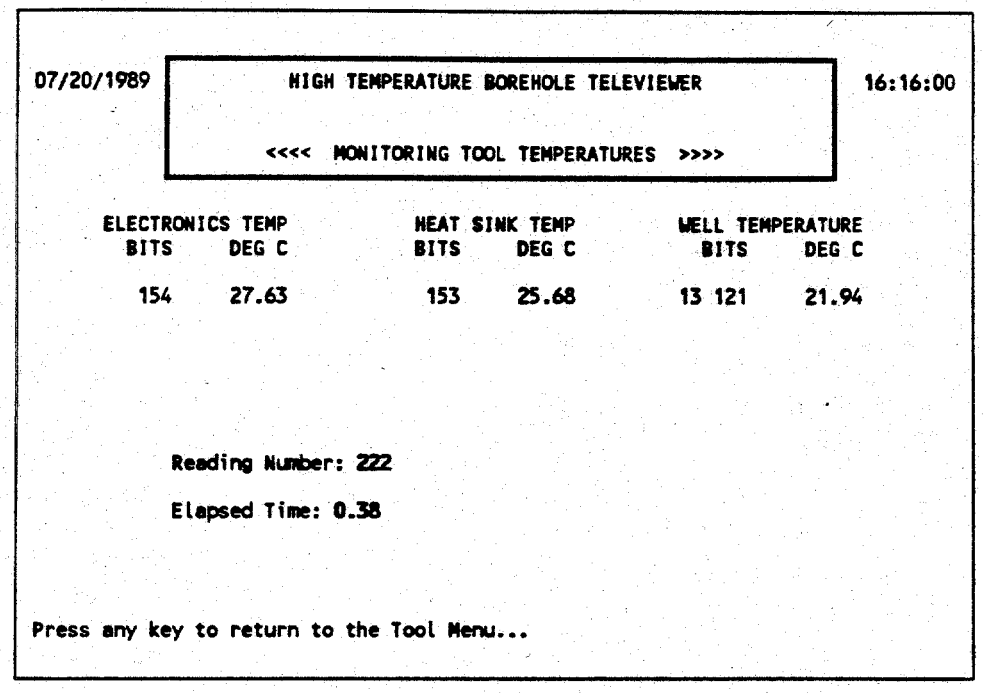


Figure II.5. An example of CRT screen displayed for monitoring the HT-BHTV temperatures. The three temperatures available from the tool are shown including the unaltered data (in bits) and the calculated temperature in °C. The elapsed time shows the time required to obtain the three temperature values from the tool. This time typically has a value of .38 seconds.

| | |
|---|---|
| Menu Item: | **Data Acquisition Menu** |
| Default Value: | Not Applicable |
| Other Values: | Not Applicable |
| Function: | This item calls the data acquisition menu which is explained in detail below. |
| Function key: | **F1**<br>Pressing this key returns the program to the Main Menu. |

### II.5.3.1 Error Messages

There are no error messages associated with this menu. However, if the computer is not properly connected to the HT-BHTV tool through the Surface Unit, the computer may hang up.

### II.5.4. Data Acquisition Menu

The CRT screen display for the Data Acquisition Menu is shown in Figure II.6. This menu allows the user to set up the ADC board in the computer and view the waveform acquired by this board. A complete description of this board and its operation is provided in Section III. The current menu item is highlighted and may be selected by pressing the Return or Enter key. The user moves between the menu items with the up or down arrow keys. The functions of the menu items shown in Figure II.6 are described below:

Menu Item: **Digitizer Gain**
Default Value: x1
Other Values: x2, x20, x200.
Function: Sets the gain of the digitizer board in the computer to the displayed value. The available gain values and the corresponding full scale voltage values are:

| | |
|---|---|
| x1 | ± 10 volts |
| x2 | ± 5 volts |
| x20 | ± 500 millivolts |
| x200 | ± 50 millivolts |

Menu Item: Sync. Threshold
Default Value: -2.441 volts
Other Values: Allowed maximum range (dependent upon the Digitizer Gain Setting):
+ 10 volts $\geq$ Sync. Threshold $\geq$ - 10 volts.
Function: Sets the value of the sync pulse threshold value to the displayed number. The sync threshold value is used by the software to check for the presence of a sync pulse. It is suggested that the user run the Data Acquisition Test and Display the acquired waveform after changing this parameter to be sure that the new value can be used to properly find the sync pulses from the HT-BHTV tool. Figure II.7 illustrates the positions of the threshold and window values on a model waveform.

Menu Item: **Range Threshold**
Default Value: 0.977 volts
Other Values: Allowed maximum range (dependent upon the Digitizer Gain Setting):
+ 10 volts $\geq$ Range Threshold $\geq$ - 10 volts.
Function: Sets the value of the range threshold value to the displayed number. The range threshold value is used by the software to check for the presence of a return signal from the side of the borehole. If the signal level is too low, then the data value will be 0 and

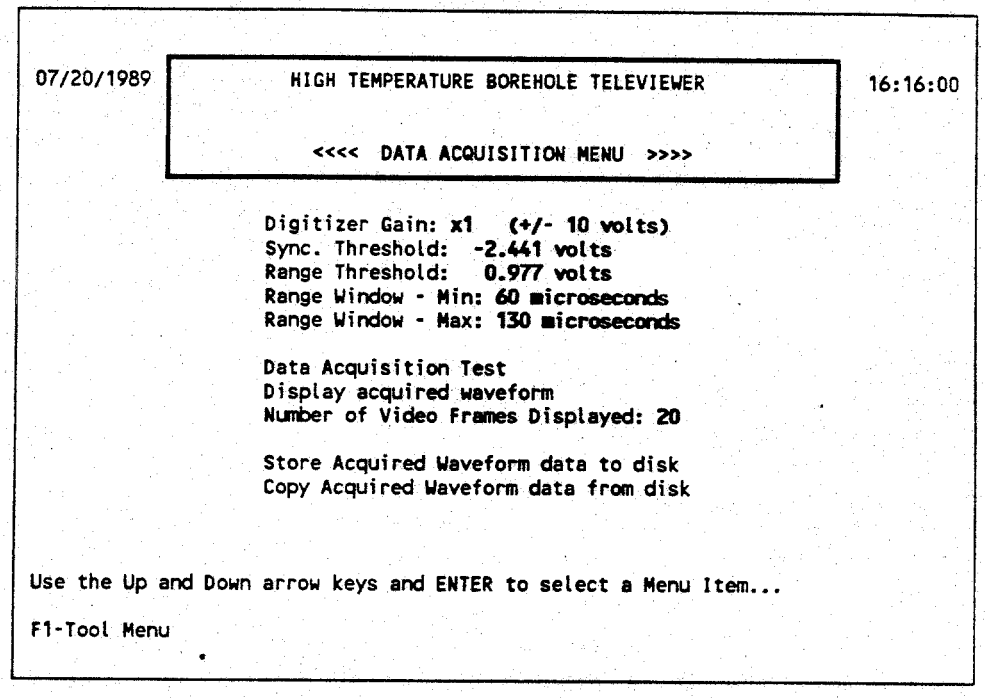


Figure II.6. An example of the CRT screen displayed for the Data Acquisition Menu using the default settings of the data acquisition parameters.

the software will display black (i.e., no color) on the screen. It is suggested that the user run the Data Acquisition Test and Display the acquired waveform after changing this parameter to be sure that the new value can be used to properly find the desired return signals from the HT-BHTV tool. Figure II.7 shows how the program uses the value of this parameter to find the return signals from the waveform acquired from the HT-BHTV tool. Further discussion of this and related data acquisition parameters may be found in Section III.

| | |
|---|---|
| Menu Item: | **Range Window - Min** |
| Default Value: | 60 microseconds |
| Other Values: | Allowed Range: |
| | 0 < Range Window - Min < Range Window - Max |
| Function: | Sets the minimum value of the range window to the displayed number. The range window is used by the software to check for the presence of a return signal from the side of the borehole. If the signal level is |

outside of the window defined by the minimum and the maximum window values, then the data value will be 0 and the software will display black on the screen. It is suggested that the user run the Data Acquisition Test and Display the acquired waveform after changing this parameter to be sure that the new value can be used properly to find the desired return signal from the tool. Figure II.7 shows how the program uses the value of this parameter to find the return signals from the waveform acquired from the HT-BHTV tool.

Menu Item: **Range Window - Max**
Default Value: 130 microseconds
Other Values: Allowed Range:
Range Window - Min < Range Window - Max < 500 microseconds.
Function: Sets the maximum value of the range window to the displayed number. The range window is used by the software to check for the presence of a return signal from the side of the borehole. If the signal level is outside of the window defined by the minimum and the maximum window values, then the data value will be 0 and the software will display black on the screen. It is suggested that the user run the Data Acquisition Test and Display the acquired waveform after changing this parameter to be sure that the new value can be used properly to find the desired return signal from tool. Figure II.7 shows how the program uses the value of this parameter to find the return signals from the waveform acquired from the HT-BHTV tool.

Menu Item: **Data Acquisition Test**
Default Value: Not applicable.
Other Values: Not Applicable.
Function: This menu item tests the data acquisition by the ADC board from the HT-BHTV tool. During the data acquisition, the acquired waveform data is stored in a default file on the virtual disk set up in the RAM of the computer. The waveform data is constantly overwritten in this file as illustrated by the record number displayed on the screen during this test. On the CRT screen, the number of heading pulses and sync pulses found by the software are displayed. Also, the

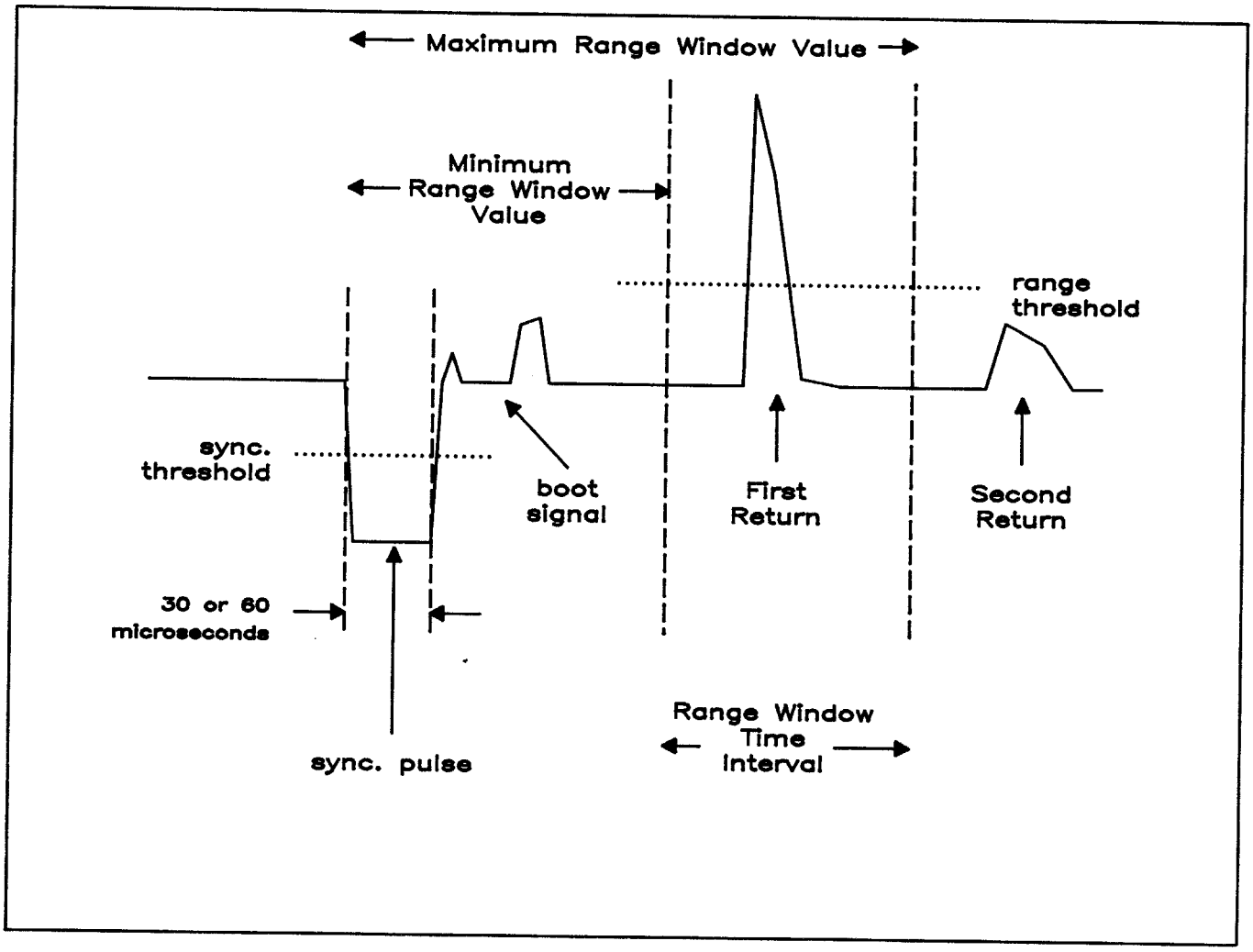


Figure II.7. An example of the positions of the sync threshold, range threshold, and the range window values on a model waveform acquired by the HT-BHTV tool from the ADC board. The sync threshold value is used to define a sync or heading pulse. Sync pulses have a width of 30 $\mu$s, whereas, a heading pulse has a width twice that of the sync pulse. The minimum and maximum values of the range window are measured from the negative slope of the sync pulse. The boot signal typically extends to about 60 $\mu$s; this tends to interfere with signals from small diameter boreholes.

difference between two heading pulses is calculated and displayed. This difference depends upon the rotation rate of the tool. The optimum values for the heading pulse difference as a function of the tool rotational speeds are:

| Tool Speed (rps) | Heading Difference |
|---|---|
| 3 | 650 |
| 6 | 325 |
| 9 | 217 |

The actual value of the heading pulse difference is dependent upon many parameters including the total cable length, the present depth (and thus the amount of cable unwound), and the environment which the cable sees. For example, it is acceptable to have a difference value in the range 645 to 648 for a tool speed of 3 rps going through perhaps 4000 ft of logging cable. If no sync pulses are counted by the program then the tool is not connected or it is not rotating or the sync threshold is not set to a suitable value. If sync pulses are counted but no heading pulses are counted then there may be a problem with the mark or magnetometer signal from the tool. The tool should be reset and the data acquisition tested again. The CRT screen that is displayed during the data acquisition test is shown in Figure II.8. The data displayed in here is described in more detail later in this section.

Menu Item: **Display acquired waveform**
Default Value: Not applicable.
Other Values: Not Applicable.
Function: This item displays the waveform currently stored in the virtual disk drive specified in the VDISK.TXT file. Examples of the waveform displayed on the CRT screen are shown in Figures II.9, II.10, II.11. By displaying the waveform, the user can check the settings of the sync and range threshold values and the range window so that the best values of these parameters may be selected. If the **Hard Copy** variable has been set to ON in the Logging/Data Display Setup Menu, then a copy of the displayed screen can be obtained by pressing the Ctl-PrtScr key. The software prints out a brief header consisting of the current date and time and the current values of the Data Acquisition variables (i.e., digitizer gain, sync and range threshold, and range window). The CRT screen shows the status of the printing operation by listing the percent of the

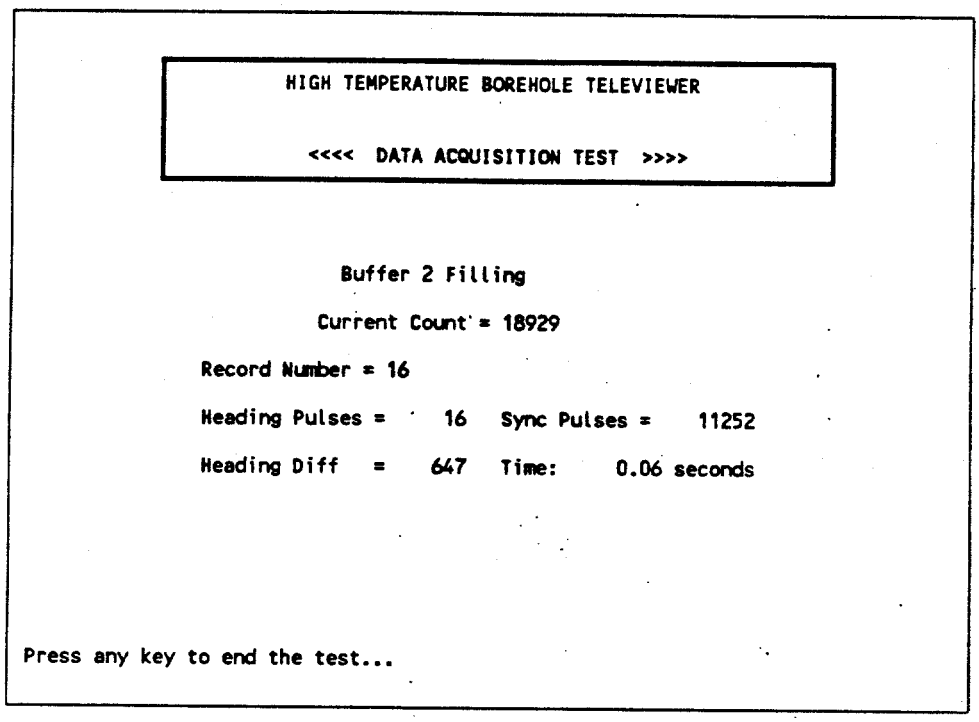


Figure II.8. An example of the CRT screen displayed when the Data Acquisition Test item is selected on the Data Acquisition Menu.

screen that has been printed. The entire printing operation takes somewhat more than two minutes.

Menu Item: **Number of Video Frames Displayed**
Default Value: 20
Other Values: Allowed Range:
1 <= Frames Displayed <= 200
Function: This item allows the user to set the number of video frames displayed when the waveform currently residing on the virtual disk is displayed. A video frame is defined as the time between sync pulses from the HT-BHTV tool and is approximately equal to 512 microseconds. The software truncates this value to 500 microseconds to calculate the number of data points displayed. Figures II.9, II.10, and II.11 illustrate the waveform displayed for 20, 5, and 200 video frames, respectively. On the screen, the sync and Range Threshold values are shown by horizontal colored

lines. When 5 or less video frames are selected for display, the current settings of the Range Window are shown by two colored vertical lines.

Menu Item: **Store Acquired Waveform data to disk**
Default Value: Not applicable.
Other Values: Not Applicable.
Function: This selection allows the user to store the current digitized waveform in a file in the BHTVDATA directory on the hard disk. The software uses the extension WAV for these files. An already existing file may not be overwritten. See the Error Messages section for a complete listing of the errors associated with this selection.

Menu Item: **Copy Acquired Waveform data from disk**
Default Value: Not applicable.
Other Values: Not Applicable.
Function: This selection prompts the user for the name of an existing waveform file on the hard disk. If the file is found, it is copied to the virtual disk overwriting any waveform data stored there.

Function key: **F1**
Pressing this key returns the program to the Tool Setup Menu.

### II.5.4.1 Error Messages

In this menu, the software allows the user to enter new values for the sync threshold, range threshold, range window, and the number of video frames. All error messages are displayed in the data entry window for a few seconds after which the software returns to the menu. The user must select the item again and properly enter the desired value. The following error messages may be displayed after the user has entered a change in one of the values:

Error Message: **Error in the input data...**
Menu Item: All data input selections.
Problem: Incorrect data entry; for example, a letter rather than a numerical value may have been entered.

Error Message: **You have exceeded the Digitizer voltage range!**
Menu Item: sync and Range Threshold values
Problem: The value entered is outside the voltage range of the ADC board at the specified Digitizer Gain. For example, with a Digitizer Gain of x1, the full scale voltage range is +/- 10 volts. Entering a value of 11 for this input will display this error message.

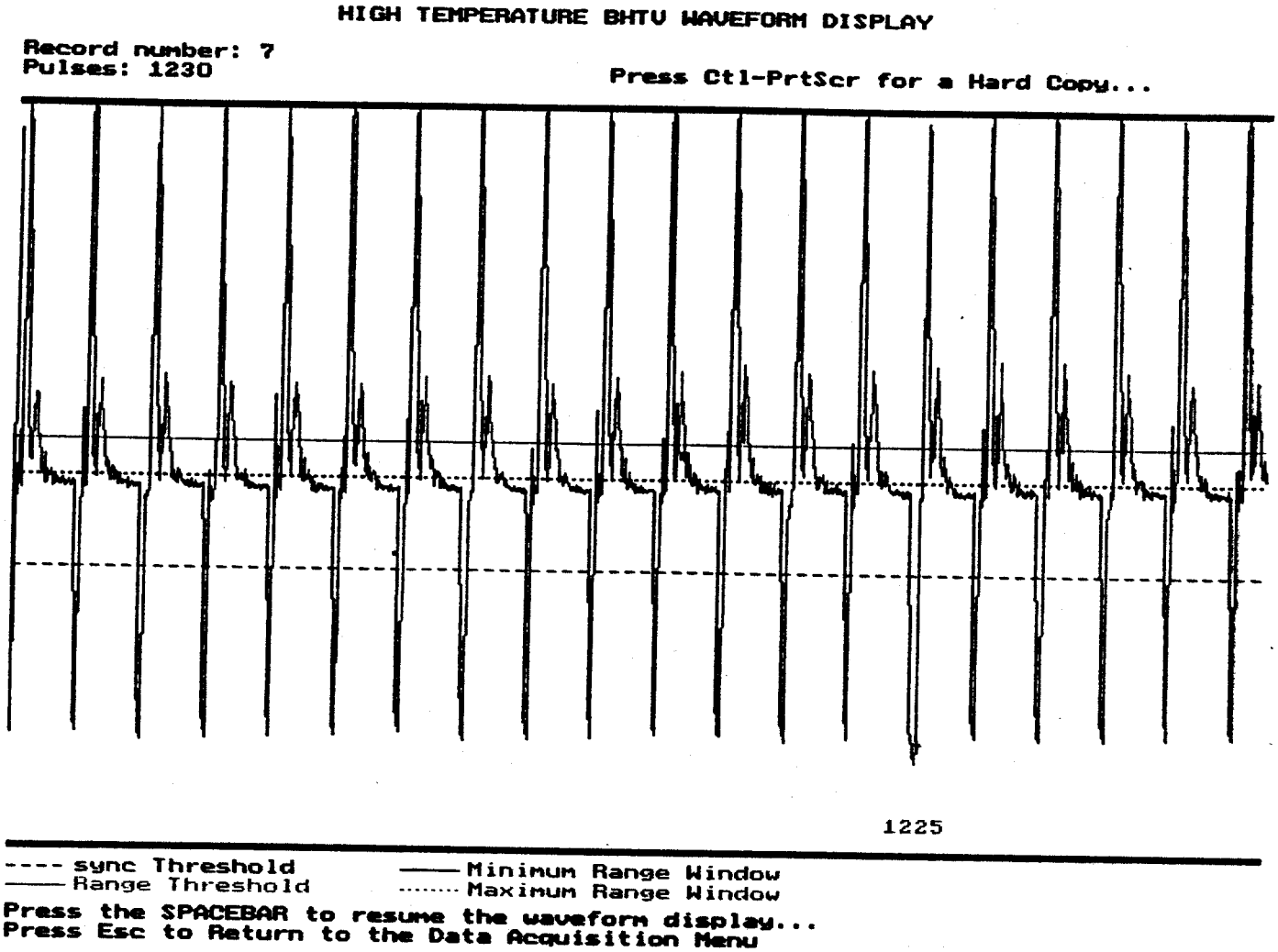


Figure II.9. An example of the CRT screen displayed when the Display acquired waveform item is selected on the Data Acquisition Menu. The default value of 20 video frames is used for the display. The display halts when a heading pulse has been located. The heading pulse is indicated by an arrow on the screen below which is shown the current sync pulse count. The dotted line in the center of the display indicates the zero voltage value.

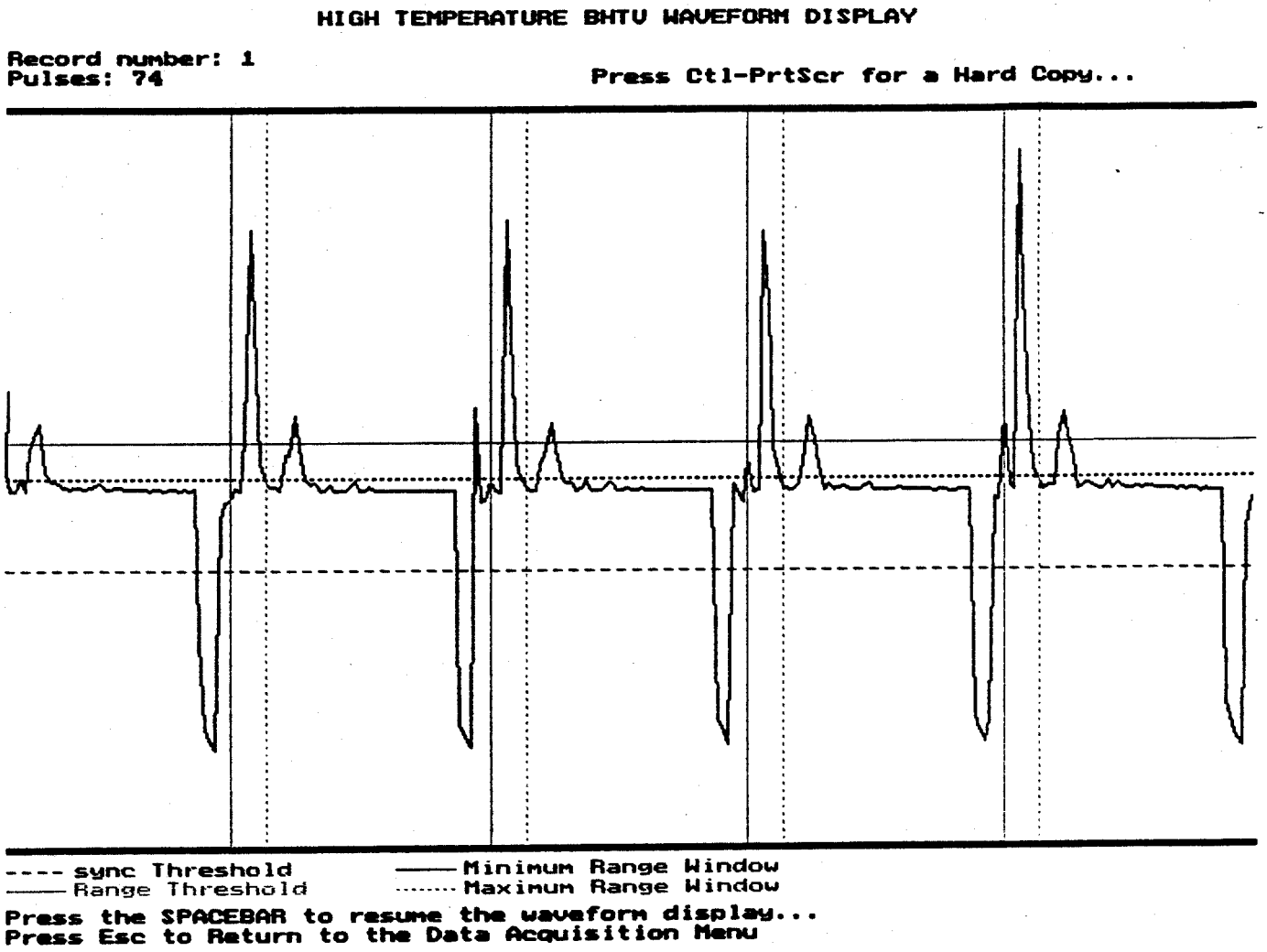


Figure II.10. An example of the CRT screen displayed when the Display acquired waveform item is selected on the Data Acquisition Menu. A value of 5 video frames is used for the display. The range time window is shown by the two vertical lines. This window is shown whenever 5 or less video frames are selected for display.

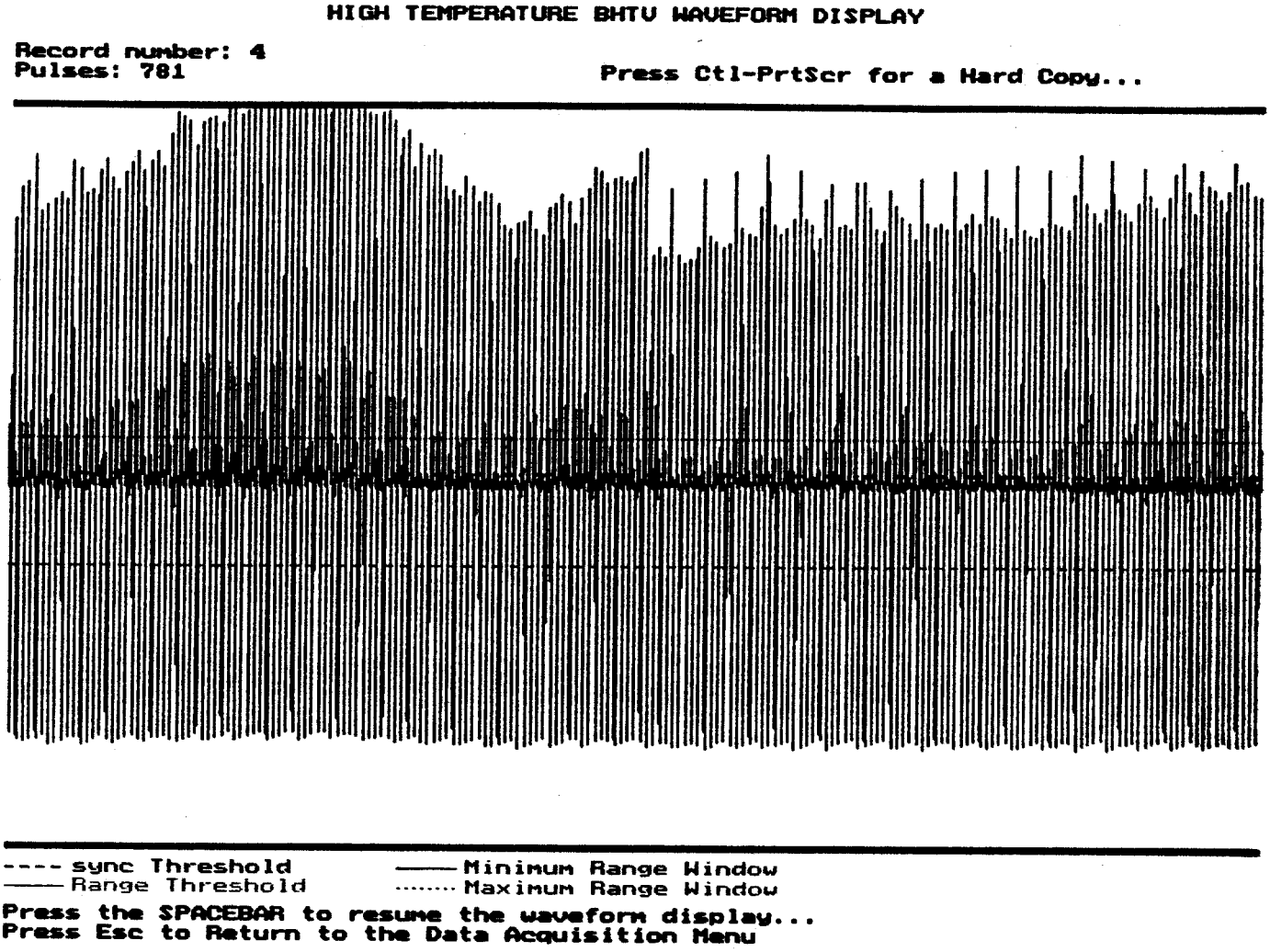


Figure II.11. An example of the CRT screen displayed when the Display acquired waveform item is selected on the Data Acquisition Menu. A value of 200 video frames is used for the display. This display may be used to monitor the peak amplitude envelope of the returned signal.

Error Message: **Error in the Range Window value!**
Menu Item: Range Window; both minimum and maximum values
Problem: The entered value for either the minimum or maximum value of the range window must be greater than 0 or less than 500 microseconds. In addition, if the minimum value exceeds the maximum value or the maximum value entered is less than the current minimum value, this error message is displayed.

Error Message: **Error in the number of video frames to display!**
Menu Item: Video frames to display
Problem: The value entered for the number of video frames displayed when the Display acquired waveform item is selected is outside the allowed range of 1 to 200 frames.

Error Message: **There is no waveform file on the virtual disk!**
Menu Item: Display Acquired Waveform
Problem: No file containing digitized waveform data is present on the virtual disk drive. A waveform must be acquired from the tool or a waveform file must be copied from the hard disk in order to display the data.

Error Message: **File Name cannot exceed 8 characters!**
Menu Item: Store/Copy Acquired Waveform
Problem: The entered name for a file was more than eight characters. The File Name must follow the MS-DOS rules for file names.

Error Message: **A File Name must be entered!**
Menu Item: Store/Copy Acquired Waveform
Problem: No characters were entered for the file name. The user pressed the Return or Enter key without entering any other characters. Pressing the Enter key at the File Name prompt allows the user to return to the Test Parameter/Setup File Menu without changing the values of the Setup parameters in memory.

Error Message: **No Waveform File named _____ exists!**
Menu Item: Copy Acquired Waveform
Problem: The entered name for the Waveform File (displayed in the blank line shown above) was not found in the BHTVDATA directory on the hard disk.

Error Message: **The Waveform File named _____ already exists!**
Menu Item: Store Acquired Waveform
Problem: The entered name for the Waveform File (displayed in the blank line shown above) already exists in the BHTVDATA directory on the hard disk. A new name must

be entered to store the waveform currently present on the virtual disk.

| | |
|---|---|
| Error Message: | **Invalid Waveform File name!** |
| Menu Item: | Store Acquired Waveform |
| Problem: | The entered name for the Waveform File is not a valid DOS file name. A new name must be entered to store the current waveform in memory. |

### II.5.5. Logging/Data Display Setup Menu

The CRT screen display for Logging/Data Display Menu is shown in Figure II.12. This menu is subdivided into two sections. The first section, as indicated on the figure, contains the Logging Parameters. The Logging Parameter variables are primarily concerned with parameters set before a logging operation with the HT-BHTV tool. The second section contains the Data Display Parameters. These are user-controlled variables which define how the data, whether newly acquired or redisplayed from stored data, are displayed on the CRT screen. Some of the variables shown in this menu do not function in this version of the software, but they are included to show other data acquisition or display parameters which may be used in later versions of the software. Those parameters which do not function are indicated by the message **Note: This parameter not available** in the menu item descriptions provided below. The current menu item is highlighted and may be selected by pressing the Return or Enter key. The user moves between the menu items with the up or down arrow keys. The functions of the menu items shown in Figure II.12 are described below:

| | |
|---|---|
| Menu Item: | **Data Mode** |
| Default Value: | TEST |
| Other Values: | BHTV, FILE |
| Function: | This item selects the value of the Data Mode variable used by the program. These three data modes are described in more detail in Section II.4 on the modes of operation of the software. |

| | |
|---|---|
| Menu Item: | **Data Acquisition Mode** |
| Default Value: | Data-Driven |
| Other Values: | Depth-Driven, From Tape |
| Function: | The three values of this variable define how the program acquires the data from the ADC board. In both the **Data-Driven** and the **Depth-Driven** acquisition mode, the program assumes that the HT-BHTV tool is connected and operating and thus the data is being obtained directly from the tool. In the **Data-Driven** mode, all the data from the tool (that is, every tool rotation) |

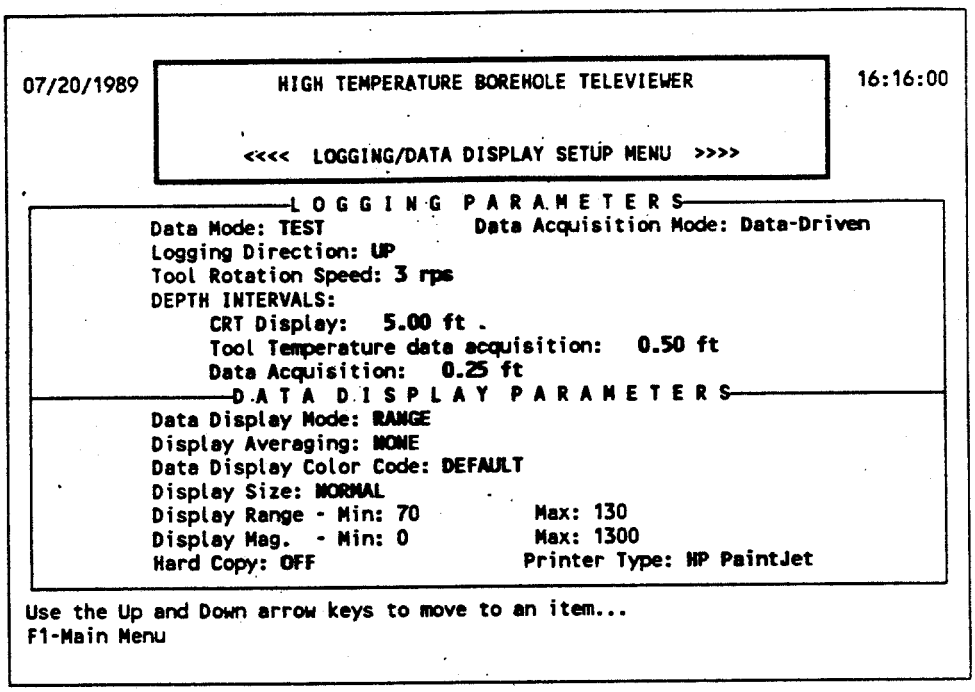


Figure II.12. An example of the CRT screen displayed for the Logging/Data Display Setup Menu with the default values of the parameters selected.

is displayed on the CRT screen and stored if the Data Mode variable is set to BHTV. In the **Depth-Driven** data acquisition mode, all the data is digitized by the computer, as in the **Data-driven** mode, but the data is only displayed and/or stored when the depth value has been incremented to the value defined under the Data Acquisition Depth Interval. This mode may be used to reduce the amount of data displayed and stored when only a low resolution look at the borehole is desired. The **From Tape** mode is used when data previously stored on a video tape is replayed for digitization and display. Note: Both the **Depth-Driven** and **From Tape** data acquisition mode are not currently available.

Item: **Logging Direction**
Default Value: UP
Other Values: DOWN
Function: This item sets the logging direction of the tool. It is used by the software to set whether the data is

displayed first at the top of the screen (when logging down) or at the bottom of the screen (when logging up). This parameter is also used for the display of the depth annotation on the CRT screen.

Menu Item: **Tool Rotation Speed**
Default Value: 3 rps
Other Values: 6 rps, 9 rps
Function: Sets the rotational speed of the tool in the software. This parameter is used by the software to set the number of pixels displayed on the CRT screen and the amount of decimation required of the original data. Section III describes the decimation of the data in more detail.

The following three items set the value of the specified depth intervals used in the software.

Menu Item: **CRT Display**
Default Value: 5.00 ft
Other Values: Allowed range > 0.01 ft
Function: This parameter sets the depth increment used for the display of the depth annotation on the CRT screen. For example, if the CRT Display depth interval is set at 5 ft then the depth will be displayed at 100, 105, 110 ft and so on assuming an initial depth of 100 ft and logging down the borehole.

Menu Item: **Tool Temperature data acquisition**
Default Value: 0.50 ft
Other Values: Allowed range > 0.01 ft
Function: This parameter sets the depth increment used for the acquisition of the temperature data from the tool.
**Note: This parameter not available.**

Menu Item: **Data Acquisition**
Default Value: 0.25 ft
Other Values: Allowed range > 0.01 ft
Function: This parameter sets the depth increment used for Depth-Driven data acquisition.
**Note: This parameter not available.**

Menu Item: **Data Display Mode**
Default Value: RANGE
Other Values: MAGNITUDE, RANGE/MAGNITUDE
Function: This function sets the display mode on the CRT screen when data is being displayed. See Section II.6 for more information on this parameter.

Menu Item: **Display Averaging**
Default Value: NONE
Other Values: x2, x4
Function: This parameter sets the amount of averaging performed by the software on the data displayed on the CRT screen. The default setting displays all the data without any averaging. The x2 or x4 setting averages either 2 or 4 lines (or records) of data and displays the averaged data line.
Note: **This parameter not available.**

Menu Item: **Data Display Color Code**
Default Value: DEFAULT
Other Values: None
Function: The color palette used for the display of range and magnitude data may be modified when this parameter is selected. Sixteen colors are available on the CRT screen. The color code display and the default color settings are described in Section II.6 on the data display selection from the Main Menu.
Note: **This parameter not available.**

Menu Item: **Display Size**
Default Value: NORMAL
Other Values: EXPANDED
Function: This parameter toggles between the NORMAL and the EXPANDED data display on the CRT screen. These two displays are described in Section II.6.

Menu Item: **Display Range - Min**
Default Value: 60 microseconds
Other Values: Allowed Range:
-10,000 <= Minimum Display Range <= +10,000.
Function: This menu item allows the user to preset the minimum value of the Display Range window for the data display. The values used here are in units of microseconds since they relate to the arrival time of the return signal from the borehole. The large range permitted (+/- 10,000) allows the user to change the color of the display to emphasize certain features or to reduce the color variation observed. This value, together with the maximum Display Range value, provides the user with a simple filtering operation on the displayed data. The values of these parameters only affect the display of the data; they have no influence on the way the data is found in the software or the value of the data stored to the hard disk. See Section II.6 for more information on the Range and Magnitude display parameters.

| | |
|---|---|
| Menu Item: | **Display Range - Max** |
| Default Value: | 130 microseconds |
| Other Values: | Allowed Range:<br>-10,000 <= Minimum Display Range <= +10,000. |
| Function: | This menu item allows the user to preset the maximum value of the Display Range window for the data display. |

| | |
|---|---|
| Menu Item: | **Display Mag. - Min** |
| Default Value: | 0 |
| Other Values: | Allowed Range:<br>-10,000 <= Minimum Display Magnitude <= +10,000. |
| Function: | This menu item allows the user to preset the minimum value of the Display Magnitude window for the data display. The magnitude data obtained from the ADC card is retained in its integer format. So, independent of the value of the digitizer gain, the magnitude data will be in the range of ± 2048. For example, with a digitizer gain of 1, the ADC board has a range of ± 10 volts. A reading of + 5 volts will have an integer value of + 1024. Changing the digitizer gain will change the range in volts of the ADC but will not affect the range of the integer-valued data from the board. As with the Display Range window, the large range of values for the Display Magnitude window allows the user to optimize the color display for the application. |

| | |
|---|---|
| Item: | **Display Mag. - Max** |
| Default Value: | 1000 |
| Other Values: | Allowed Range:<br>- 10,000 <= Minimum Display Magnitude <= 10,000. |
| Function: | This menu item allows the user to preset the maximum value of the Display Magnitude window for the data display. |

| | |
|---|---|
| Menu Item: | **Hard Copy** |
| Default Value: | OFF |
| Other Values: | ON |
| Function: | Setting this item to **ON** allows the user to make hard copies of the CRT screen during the display of stored data or during data acquisition when the acquisition has been paused. The software checks whether a printer is connected and operating before it toggles this item to **ON**. If no printer is found, this item remains **OFF**. |

| | |
|---|---|
| Menu Item: | **Printer Type** |
| Default Value: | HP PaintJet |
| Other Values: | None |
| Function: | Only the Hewlett Packard PaintJet Color printer is currently supported by the software. This printer provides a color hard copy of the CRT screen when data is displayed. Refer to Section III. for more information on the operation and the programming of this printer. |
| Function key: | **F1**<br>Pressing this key returns the program to the Main Menu. |

### II.5.5.1 Error Messages

In this menu, the software allows the user to enter new values for the three depth interval increments and the minimum and maximum values of the Display Range and the Display Magnitude. All error messages are displayed in the data entry window for a few seconds after which the software returns to the menu. The user must select the item again and properly enter the desired value. The following error messages may be displayed after the user has entered a change in one of the values:

| | |
|---|---|
| Error Message: | **Error in the input data...** |
| Menu Item: | All data input selections. |
| Problem: | Incorrect data entry; for example, a letter rather than a numeral value may have been entered. |
| Error Message: | **Data value must be greater then zero.** |
| Menu Item: | All Depth Intervals |
| Problem: | The entered value of the depth interval must be a positive number. The software only deals in positive numbers for the depth. Logging up or down a well is specified by the Logging Direction variable in this menu. |
| Error Message: | **Range Display value must be >= -10,000 or <= +10,000.** |
| Menu Item: | Both the minimum and maximum Range Display items. |
| Problem: | The software only permits the Range Display values in the specified range. The entered value is outside of this range. |
| Error Message: | **Minimum value of the Range Display cannot exceed or equal the maximum value.** |
| Menu Item: | Minimum Range Display item |
| Problem: | The entered value was larger than the current maximum value of the Range Display interval. |

| | |
|---|---|
| Error Message: | **Maximum value of the Range Display cannot be less than the minimum value.** |
| Menu Item: | Maximum Range Display item |
| Problem: | The entered value was less than the current minimum value of the Range Display interval. |
| Error Message: | **Magnitude Display value must be >= -10,000 or <= +10,000.** |
| Menu Item: | Both the minimum and maximum Magnitude Display items. |
| Problem: | The software only permits the Magnitude Display values in the specified range. The entered value is outside of this range. |
| Error Message: | **Minimum value of the Magnitude Display cannot be >= the maximum value.** |
| Menu Item: | Minimum Magnitude Display item |
| Problem: | The entered value was larger than the current maximum value of the Magnitude Display interval. |
| Error Message: | **Maximum value of the Magnitude Display cannot be <= the minimum value.** |
| Menu Item: | Maximum Magnitude Display item |
| Problem: | The entered value was less than the current minimum value of the Magnitude Display interval. |

### II.5.6. BHTV File Menu

The BHTV File Menu has a different format than the other menus described. In the menus described previously, the user changed the values of the parameters in the menu to the values desired for a particular operation; for example, the display of previously stored data requires different settings for the parameters than the settings required for data acquisition from the HT-BHTV tool. In the File Menu, additional information is displayed in the menu depending on the type of file currently assigned. When no file has been assigned by the user, the CRT screen display for the File Menu is as shown in Figure II.13. There are two types of files defined by the HT-BHTV software. These are called **NEW** or **OLD** files. **NEW** files are used to store data from the HT-BHTV tool (or if the Tool Flag variable is False, simulated data, constructed by the software, will be stored in the file). Only **NEW** files may be used to store "new" data, that is, no data may be appended to an existing file containing previously stored data. **OLD** files are those files containing data stored from an earlier operation of the software (again, the data may be either from the tool or simulated data from the test). The software automatically labels a file as either **NEW** or **OLD**. When the user selects the File Name item in the menu and types in the name of a file, the software checks whether a file of that name exists on the hard disk. If the file exists, it is labeled OLD and the information stored about the file is read from the file. (Note: For further information concerning the data files used by the software refer to Section III.) If a file of the name entered by the user does not exist, then the file is labeled **NEW** and the CRT screen shown in Figure II.14 is displayed. An example of the CRT screen displayed for an OLD file is shown in Figure II.15. For the menu items shown on the bottom of the screen, the highlighted menu items may be selected by pressing the Return or Enter key. The user moves between the menu items with up or down arrow keys. The menu items selected by the user will be described first. The additional information displayed by the menu will be discussed following the discussion of the menu items. The user should refer to the CRT screen displays shown in Figures II.13, II.14, and II.15.

**User-Selected Menu Items**

| | |
|---|---|
| Menu Item: | **File Name** |
| Default Value: | NONE |
| Other Values: | User-selected file name. |
| Function: | Selecting this item displays a small window on the CRT screen which prompts the user for the name of a file. Only eight character names without extensions are permitted for the file name. The software provides its own extensions for the files as explained in Section III. After a file name is entered the software checks the BHTVDATA subdirectory for a file of that name. If one is found with that name, it is labeled an **OLD** file. If a file of the selected name |

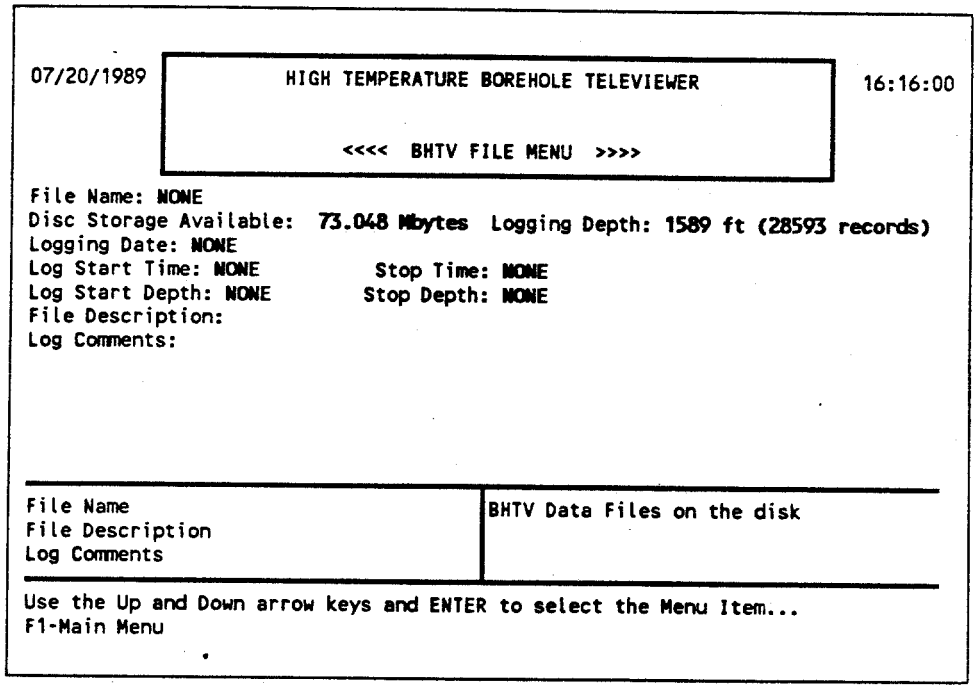


Figure II.13. An example of the CRT screen displayed for the BHTV File Menu when no file has been assigned.

does not exist, the file is a NEW file and the software prepares the appropriate data files on the hard disk.

Menu Item: **File Description**
Default Value: Not applicable
Other Values: Not applicable
Function: Selecting this item displays a small window on the CRT screen which prompts the user for a description of the file. For example, the user may choose to include the well logged and other pertinent information in this description. The description is displayed by the software when the directory of data files on the hard disk is selected. See BHTV Data Files on the disk below. The description is limited to 60 characters.

Menu Item: **Log Comments**
Default Value: Not applicable
Other Values: Not applicable
Function: Selecting this item displays a small window on the CRT screen which prompts the user for comments to be

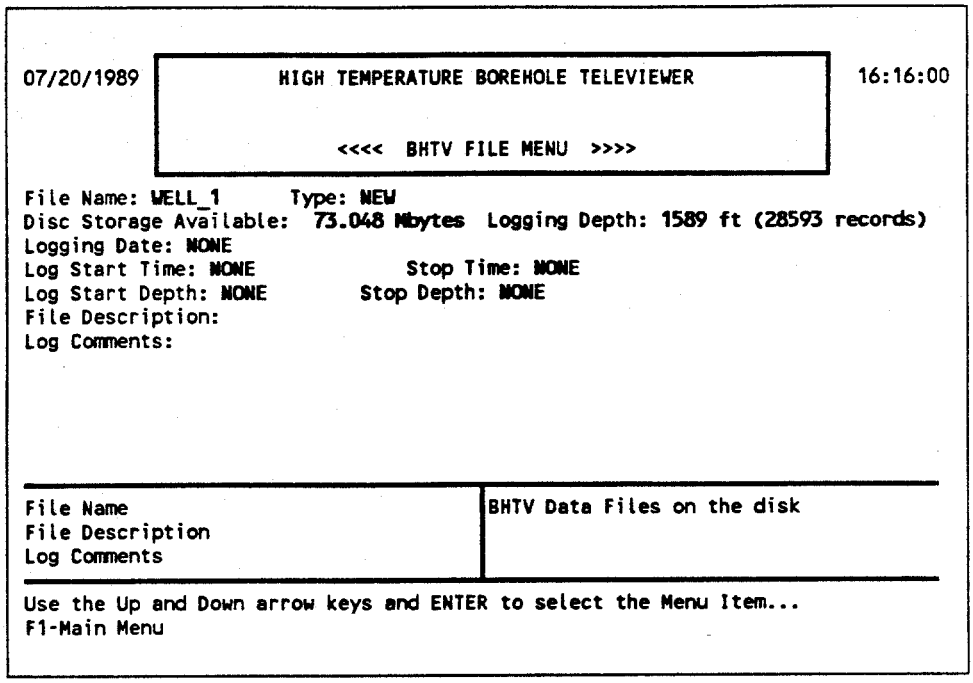


Figure II.14. An example of the CRT screen displayed for the BHTV File Menu when a NEW file is selected.

stored with the data in this file. Five 78-character lines of comments may be added by the user for each file. When this item is selected, the software cycles through each of the comment lines. Information may be appended to but not deleted from a previously entered comment. Pressing the Enter key concludes the input for the specified comment line.

Menu Item: **BHTV Data Files on the disk**
Default Value: Not applicable
Other Values: Not applicable
Function: When this item is selected, the program searches the BHTVDATA directory for all HT-BHTV data files (refer to Section III). After the search, all the files found are displayed, up to a maximum value of 100 files, in a window as shown in the example of Figure II.16. In the display, the number of data files found is shown and each individual file is listed by its eight character name, the logging date, and the user-supplied file description. Fifteen files are displayed at a time. The software directs the user to

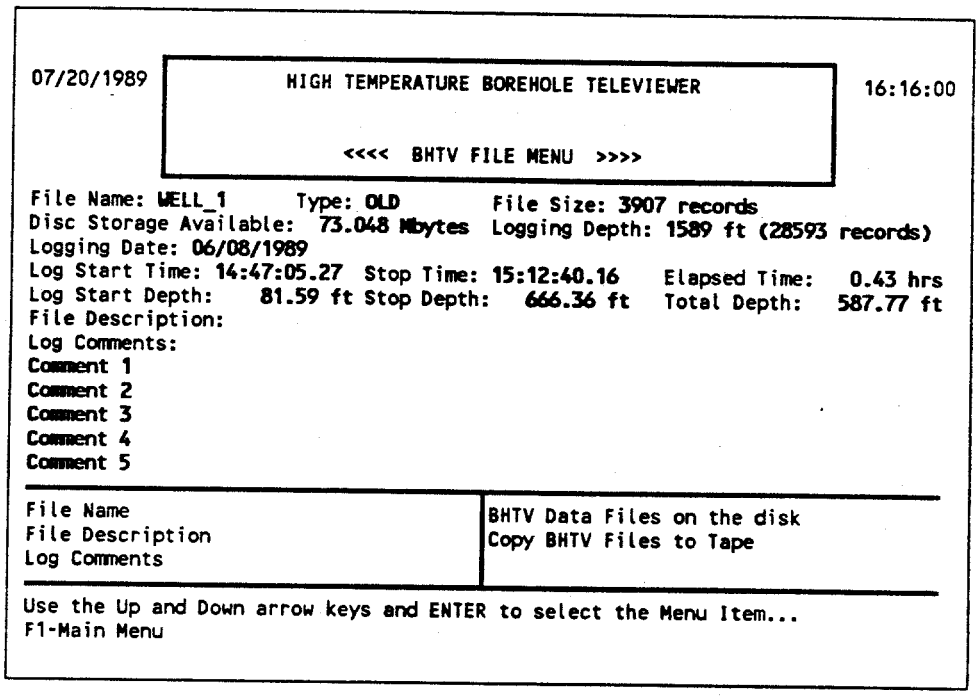


Figure II.15. An example of the CRT screen displayed for the BHTV File Menu when a OLD file is selected.

press a key to continue the file listing or to return to the BHTV File Menu if the last screen is displayed.

**Additional Information Displayed in the Menu**

| | |
|---|---|
| Menu Item: | Type |
| Default Value: | Dependent on the file named by the user. |
| Other Values: | NEW, OLD |
| Function: | NEW files are used to store data from a logging operation. OLD files contain data previously stored from the tool (or simulated data constructed by the software). The data in these files may be viewed on the CRT screen but no additional data may appended to these files. A complete description of the data files produced by the HT-BHTV program is provided in Section III. |

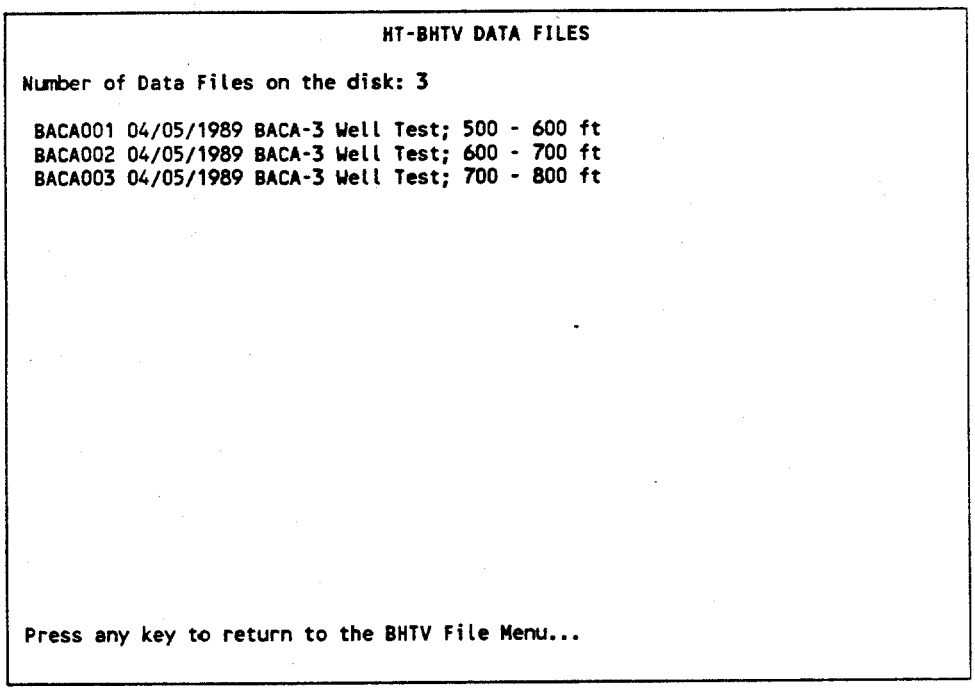


Figure II.16. An example of the CRT screen displayed for the listing of HT-BHTV files on the hard disk which are available for display.

Menu Item: **File Size**
Default Value: Displayed only for an **OLD** file.
Other Values: Not applicable
Function: The file size is the total number of records or horizontal lines which may be displayed on the CRT screen for the indicated file. For example, in Figure II.15, the display shows that this file contains 3907 records. Since each record corresponds to a display line and 460 lines may be displayed on the CRT screen in the **NORMAL** display size mode, then this file contains the equivalent of 8.5 CRT screens of HT-BHTV data.

Menu Item: **Disc Storage Available**
Default Value: Not applicable
Other Values: Not applicable
Function: This item shows the storage capacity remaining on the hard disk. This number can be used to estimate whether space exists on the disk for the storage of additional data. The amount of storage available on the disk is shown in Mbytes. To convert this value to

bytes, multiply the displayed value by 1,024,000. (Note that about 1.175 Mbytes of disk storage is required for each CRT screen in the **NORMAL** display size mode. The depth displayed on the screen will depend on the logging rate and the Data Acquisition Mode selected in the Logging/Data Display Setup Menu. For example, with a logging rate of 5 ft/min, about 12.8 ft of data may be displayed on the screen in the **NORMAL** display size mode.) If only a small amount of space is available, it is advisable to archive some of the HT-BHTV data on the disk to tape. See Section II.7 for more details about this procedure.

Menu Item: **Logging Depth**
Default Value: Not applicable
Other Values: Not applicable
Function: This item displays two pieces of information related to the empty storage capacity on the hard disk. The number of records (or lines) of data that may be stored on the system is computed from the amount of storage available (see above) and the size in bytes of a data record in the digitized data files (those files with a .BTV extension; see Section III for more information on the data file structure used by the HT-BHTV software). The computed record number is used to estimate the depth (in ft) which may be logged at a logging rate of 10 ft/min. The number displayed here may be easily converted to a logging depth at any other logging rate. For example, at a logging rate of 5 ft/min, the estimated depth that may be logged can be found by multiplying the displayed depth by 0.5.

Menu Item: **Logging Date**
Default Value: NONE for a **NEW** file.
Other Values: The date the data was acquired/stored for an **OLD** file.
Function: This item displays the date on which the data contained in the specified **OLD** file was obtained and stored.

Menu Item: **Log Start Time**
Default Value: NONE for a **NEW** file.
Other Values: The time at which the logging operation was started for an **OLD** file.
Function: This item displays the starting time of the logging operation for the data stored in the specified **OLD** file.

| | |
|---|---|
| Menu Item: | **Log Stop Time** |
| Default Value: | NONE for a **NEW** file. |
| Other Values: | The time at which the logging operation was stopped for an **OLD** file. |
| Function: | This item displays the stopping time of the logging operation for the data stored in the specified **OLD** file. |

| | |
|---|---|
| Menu Item: | **Elapsed Time** |
| Default Value: | Not displayed for a **NEW** file. |
| Other Values: | Elapsed logging time in hours for an **OLD** file. |
| Function: | This item displays the result of the calculation of the total logging time from the Start and Stop times of the data acquisition stored in the specified **OLD** file. |

| | |
|---|---|
| Menu Item: | **Log Start Depth** |
| Default Value: | NONE for a **NEW** file. |
| Other Values: | The depth at which the logging operation was started for an **OLD** file. |
| Function: | This item displays the starting depth in feet of the logging operation for the data stored in the specified **OLD** file. |

| | |
|---|---|
| Menu Item: | **Log Stop Depth** |
| Default Value: | NONE for a **NEW** file. |
| Other Values: | The depth in feet at which the logging operation was stopped for an **OLD** file. |
| Function: | This item displays the depth at which data acquisition for a logging operation was stopped. |

| | |
|---|---|
| Menu Item: | **Total Depth** |
| Default Value: | Not displayed for a **NEW** file. |
| Other Values: | Total depth logged in feet for an **OLD** file. |
| Function: | This item displays the difference between the starting and stopping depth for the data acquisition from the HT-BHTV tool during a logging operation. |

| | |
|---|---|
| Function key: | **F1** |
| | Pressing this key returns the program to the Main Menu. |

### II.5.6.1 Error Messages

In this menu, the software allows the user to enter a new File Name for either data acquisition or display of previously acquired data. All error messages are displayed in the data entry window for a few seconds after which the software returns to the menu. The user must select the item again and properly enter the desired value. The following error messages may be displayed after the user has entered a change in one of the values:

| | |
|---|---|
| Error Message: | **File Name cannot exceed 8 characters!** |
| Menu Item: | File Name |
| Problem: | The entered name for a file was more than eight characters. The File Name must follow the MS-DOS rules for file names. |
| Error Message: | **A File Name must be entered!** |
| Menu Item: | File Name |
| Problem: | No characters were entered for the file name. The user pressed the Return or Enter key without entering any other characters. Pressing the Enter key at the File Name prompt allows the user to return to the BHTV File Menu without changing the file already opened. |
| Error Message: | **Invalid File Name!** |
| Menu Item: | File Name |
| Problem: | An incorrect File Name was entered. Most likely the name included some invalid characters. The file names must conform to acceptable MS-DOS names. |

## II.5.7. File Display Menu

The initial or default CRT screen displayed for the File Display menu is shown in Figure II.17. This menu allows the user to selectively view the data acquired and stored from the HT-BHTV tool. The format of this menu is similar to the BHTV File Menu. In this menu, additional information pertaining to the selected file is displayed to aid the user in choosing an appropriate depth or record number interval to display. Two other figures provide examples of the CRT display when either the depth or record number interval is selected. Figure II.18 shows an example of the display when the user selects a depth interval range. Figure II.19 is an example of the screen when the record number interval is selected. For the menu items shown on the bottom portion of the screen, the highlighted menu item may be selected by pressing the Return or Enter key. The user moves between the menu items with up or down arrow keys. The user-selected menu items will be discussed first followed by a brief summary of the additional information displayed on the screen. This additional information is identical to the information shown in the BHTV File Menu which was described in Section II.5.6.

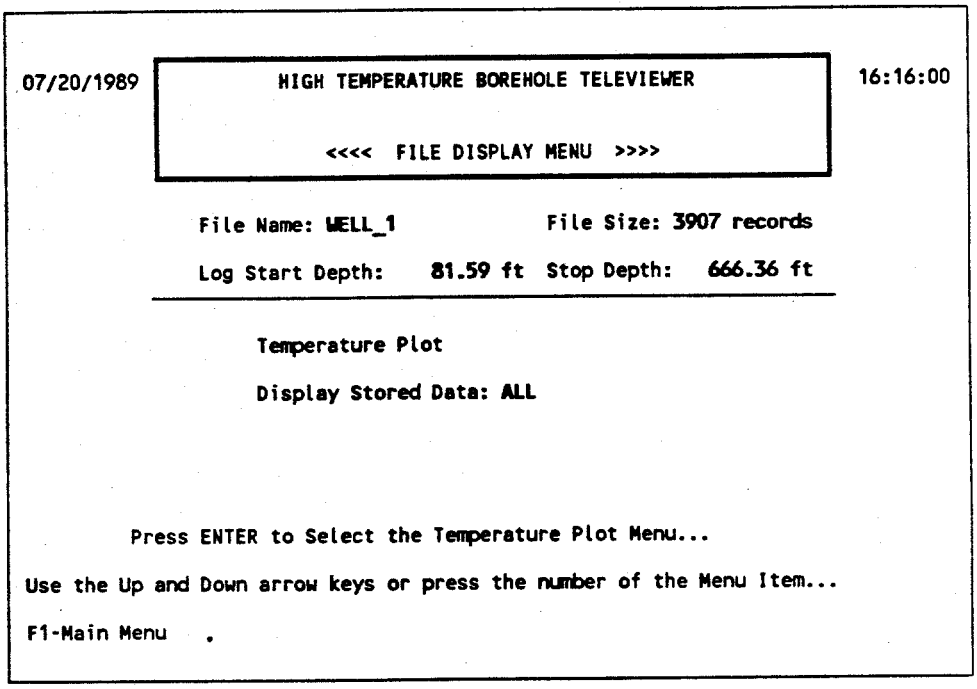


Figure II.17. An example of the CRT screen displayed for the File Display Menu for the initial or default display.

**User-Selected Menu Items**

| | |
|---|---|
| Menu Item: | **Temperature Plot** |
| Default Value: | Not applicable |
| Other Values: | Not applicable |
| Function: | This item allows the user to display the temperature data acquired from the tool stored in the specified file. Note: This menu item is not presently available. |

| | |
|---|---|
| Menu Item: | **Display Stored Data** |
| Default Value: | ALL |
| Other Values: | PARTIAL |
| Function: | This item allows the user to select the manner in which the stored data will be displayed. In the default **ALL** selection, the data will be displayed beginning at record number 0 (which is the first record stored in the file) to the last record number of the file. The **PARTIAL** selection allows the user to choose to display only a portion of the data stored in the |

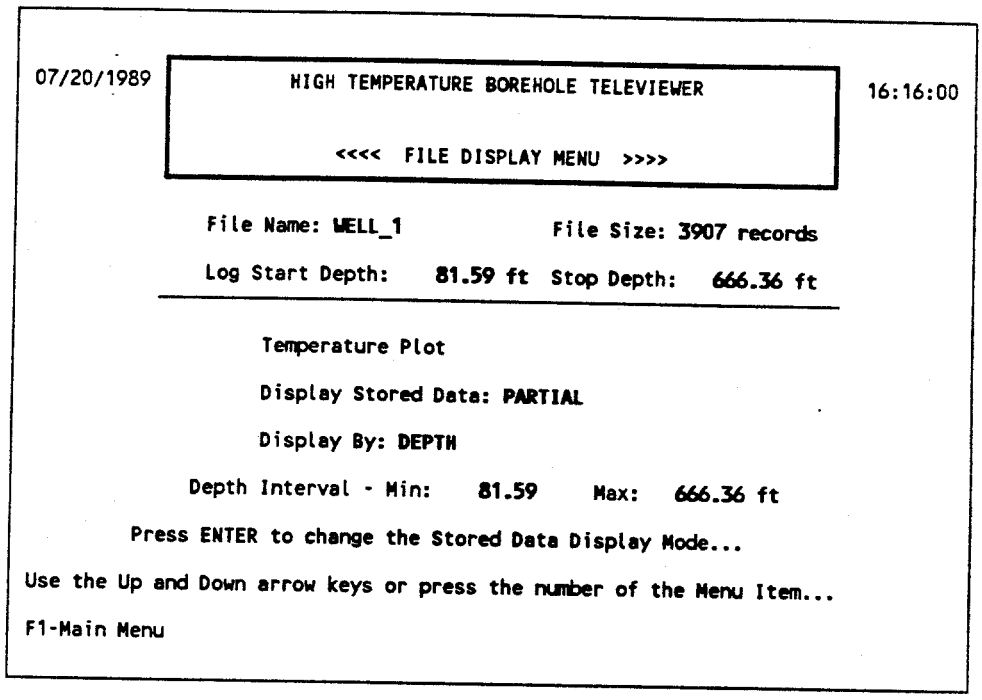


Figure II.18. An example of the CRT screen displayed for the File Display Menu for the Depth Interval Display.

specified file. The user may select to display the data by either the depth or record number interval. These are selected by the following menu item.

Menu Item: **Display By**
Default Value: DEPTH
Other Values: RECORD NUMBER
Function: This item is only displayed on the CRT screen when the user selects the **PARTIAL** selection of the Display Stored Data item described above. Two selections are available in this menu item. The default select of **DEPTH** allows the user to specify a depth interval to display. **RECORD NUMBER** directs the software to display the data according to the record number interval specified in the menu item below.

Menu Item: **Depth Interval**
Default Value: Minimum and maximum logged depths contained in the specified file.
Other Values: User-specified
Function: When the Display By menu item is set to DEPTH, this

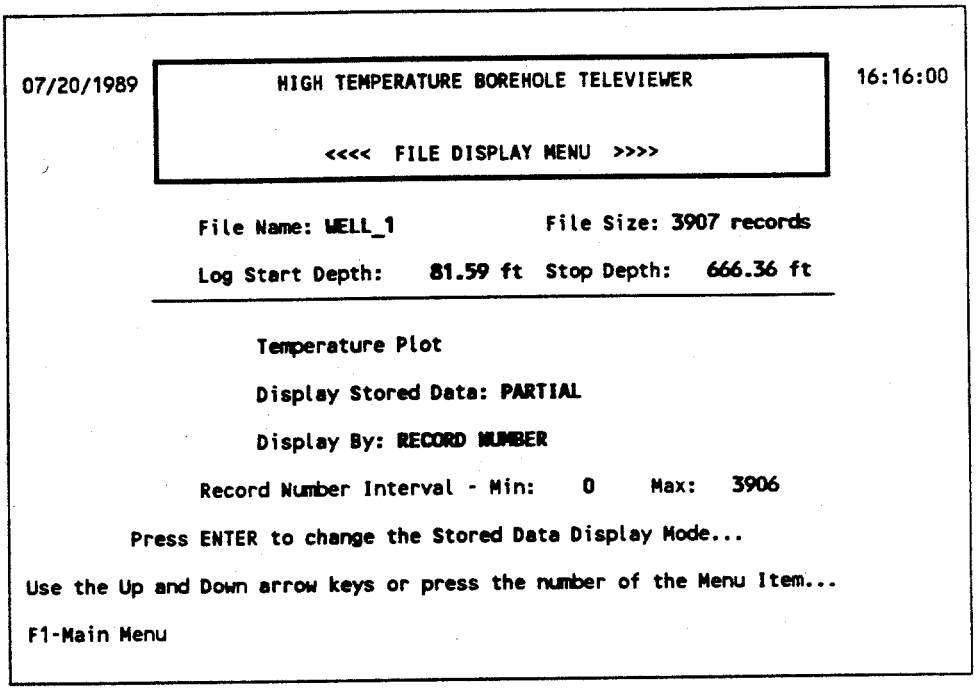


Figure II.19. An example of the CRT screen displayed for the File Display Menu for the Record Number Interval display.

menu item is shown on the CRT screen. Selecting this item by pressing the Return or Enter key allows the user to specify the depth range which should be displayed from the specified file. The software only permits a depth interval which is within the logging depths contained in the file. The user enters the minimum depth value followed by the maximum depth value. These values are the true minimum and maximum depths desired by the user irrespective of the logging direction of the data in the file. The software will display the data properly depending upon the logging direction. An example of the CRT screen display for this option is shown in Figure II.18.

Menu Item: **Record Number Interval**
Default Value: Record number range from 0 to the last record in the file.
Other Value: User-specified
Function: When the Display By menu item is set to RECORD NUMBER, this menu item is shown on the CRT screen. Selecting this item by pressing the Return or Enter key allows

the user to specify the record number range which should be displayed from the specified file. Of course, the user is limited to the record numbers available in the file. Any record number selection outside of this range produces an error message by the software. An example of the CRT screen display for this option is shown in Figure II.19.

**Additional Information Displayed in the Menu**

| | |
|---|---|
| Display Item: | **File Name** |
| Function: | User-selected file name. |
| Display Item: | **File Size** |
| Function: | The file size is the total number of records or horizontal lines which may be displayed on the CRT screen for the indicated file. The file size shows the total records in the specified file. Since the file begins at record number 0, the last record in the file is equal to File Size - 1. |
| Display Item: | **Log Start Depth** |
| Function: | The depth at which the logging operation was started for the specified file. |
| Display Item: | **Log Stop Depth** |
| Function: | The depth at which the logging operation was stopped for the specified file. |
| Function key: | **F1** Pressing this key returns the program to the Main Menu. |

### II.5.7.1 Error Messages

In this menu, the software allows the user to enter new Depth or Record Number intervals for displaying only a portion of the data contained in a file. Before entering this menu, the user must have opened a file for data display in the BHTV File Menu. If no OLD file was opened, the software displays the first error message shown below and returns to the Main Menu. All error messages are displayed in the data entry window for a few seconds after which the software returns to the menu. The user must select the item again and properly enter the desired value. The following error messages may be displayed after the user has entered a change in one of the values:

Error Message: **A previously existing File must be opened...**
Problem: An OLD file must be opened from the BHTV File Menu prior to entry into this menu.

Error Message: **Error in the input data...**
Menu Item: All data input selections.
Problem: Incorrect data entry; for example, a letter rather than a numerical value may have been entered.

Error Message: **Data value must be a positive number.**
Menu Item: Depth Interval and Record Number Interval
Problem: The user entered a negative number for one of the interval values.

Error Message: **The value entered is less than the Minimum depth in the file...**
Menu Item: Depth Interval
Problem: The value entered was less than the minimum depth in the specified file.

Error Message: **The value entered is greater than the Maximum depth in the file...**
Menu Item: Depth Interval
Problem: The value entered was greater than the maximum depth in the specified file.

Error Message: **The value entered is less than the Minimum depth previously entered...**
Menu Item: Maximum value of the Depth Interval
Problem: The maximum value of the Depth Interval entered was less than the minimum value just entered. The user must properly enter a minimum and maximum value for the Depth Interval which will be displayed from the specified file.

Error Message: **The value entered is greater than the Maximum record no. in the file**
Menu Item: Record Number Interval
Problem: The value entered was greater than the maximum record number of the specified file.

Error Message: **The value entered is less than the Minimum record no. previously entered...**
Menu Item: Maximum value of the Record Number Interval
Problem: The maximum value of the Record Number Interval entered was less than the minimum value just entered. The user must properly enter a minimum and maximum value for the Record Number Interval which will be displayed from the specified file.

## II.5.8. Test Parameter/Setup File Menu

This menu sets the user-controlled software flags used in the software. Section II.3 discusses the use of these flags. The CRT screen display for this menu is shown in Figure II.20. The current menu item is highlighted and may be selected by pressing the Return or Enter key. To move between the menu items, the user may either select the number of the desired item or move between the items by using the up or down arrow keys. As shown in the example in Figure II.20, each menu item has a short descriptive message explaining the function of the highlighted menu selection.

| | |
|---|---|
| Menu Item: | **Tool Flag** |
| Default Value: | False |
| Other Values: | True |
| Function: | The Tool Flag should be set to True when the HT-BHTV tool is connected to the computer system and the user wishes to acquire temperature and/or acoustic data from the tool. Also, this flag must be True if the ADC board will be used to digitize the data stored on a video tape. |
| Menu Item: | **Depth Flag** |
| Default Value: | False |
| Other Values: | True |
| Function: | The Depth Flag must be True to acquire the depth information from the depth counter. With this flag set to false, the software calculates its own depth beginning at a value of 22000 ft and incrementing (or decrementing, depending upon the value of the Logging Direction variable) this depth by 0.0556 ft for each line of data displayed on the CRT screen. This incremental value simulates a logging rate of 10 ft/min. |
| Menu Item: | **Temperature Flag** |
| Default Value: | False |
| Other Values: | True |
| Function: | The Temperature Flag variable must be True for the software to acquire and display temperature data. If the Tool Flag is True, the software will acquire the temperature data from the HT-BHTV tool and display the converted temperatures on the CRT screen. Note: The serial interface on the computer must be connected to the interface on the HT-BHTV surface unit so that the software may obtain the data from the tool. If the Tool Flag is False and the Temperature Flag is True, the software will display simulated temperature values. When the Temperature Flag is False, no temperature information is acquired or displayed. |

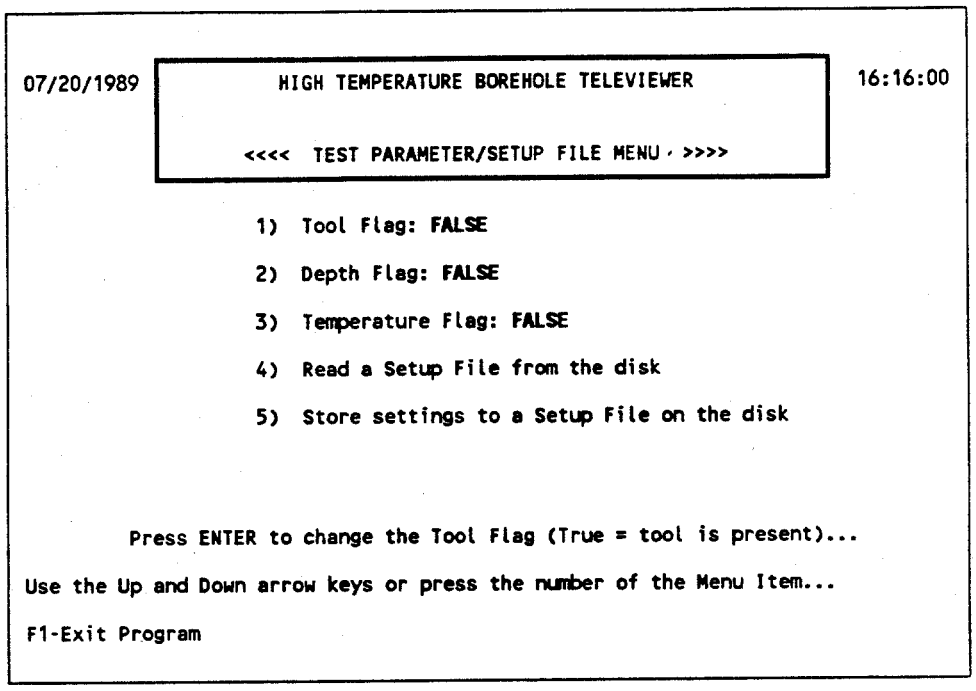


Figure II.20. An example of the CRT screen displayed for the Test Parameter/ Setup File Menu using the default settings of the flag variables.

Menu Item: **Read a Setup File from the disk**
Default Value: Not Applicable
Other Values: Not Applicable
Function: Selecting this item displays a small window on the CRT screen which prompts the user for the name of the desired Setup File. Setup files are stored in the BHTVDATA directory with the extension .SET. As in the BHTV File Menu, the software adds the correct extension to the Setup File. The user must enter a valid eight character name for the file. No extension **should be added by the user.** The software will check the disk for a Setup File of the specified name. If the file is found, the setup data contained in the file will be read by the program. If no file is found, an error message is displayed. The Setup File stores the Tool Control parameters and the values of the Display Window which were selected when the file was originally stored. The following parameters are contained in the Setup File:

Digitizer Gain
sync Threshold
Range Threshold
Range Window (min. and max. values)
Range Display Window (min. and max. values)
Magnitude Display Window (min. and max. values)

Menu Item: **Store settings to a Setup File on the disk**
Default Value: Not Applicable
Other Values: Not Applicable
Function: Selecting this item displays a small window on the CRT screen which prompts the user for the name of the Setup File. The current values of the variables listed above will be stored in the Setup File. The software checks the disk to determine if a Setup File of the specified name already exists. If it does, an error message is displayed. **Setup Files may not be overwritten by the program.** If no file of the user-supplied name is found on the disk, the software stores the information in the file and returns to the Test Parameter/Setup File Menu.

Function key: F1
Pressing this key returns the program to the Main Menu.

### II.5.8.1 Error Messages

In this menu, the software allows the user to enter a Setup File Name to store current settings to the disk or to change the setup settings to those contained in the specified file. All error messages are displayed in the data entry window for a few seconds after which the software returns to the menu. The user must select the item again and properly enter the desired value. The following error messages may be displayed after the user has entered a Setup File name:

| | |
|---|---|
| Error Message: | **File Name cannot exceed 8 characters!** |
| Menu Item: | Store/Read Setup File |
| Problem: | The entered name for a file was more than eight characters. The File Name must follow the MS-DOS rules for file names. |
| Error Message: | **A File Name must be entered!** |
| Menu Item: | Store/Read Setup File |
| Problem: | No characters were entered for the file name. The user pressed the Return or Enter key without entering any other characters. Pressing the Enter key at the File Name prompt allows the user to return to the Test Parameter/Setup File Menu without changing the values of the Setup parameters in memory. |
| Error Message: | **No Setup File named _____ exists!** |
| Menu Item: | Read Setup File |
| Problem: | The entered name for the Setup File (displayed in the blank line shown above) was not found in the BHTVDATA directory on the hard disk. |
| Error Message: | **The Setup File named _____ already exists!** |
| Menu Item: | Store Setup File |
| Problem: | The entered name for the Setup File (displayed in the blank line shown above) already exists in the BHTVDATA directory on the hard disk. A new name must be entered to store the current settings of the Setup parameters. |
| Error Message: | **Invalid Setup File name!** |
| Menu Item: | Store Setup File |
| Problem: | The entered name for the Setup File is not a valid DOS file name. A new name must be entered to store the current settings of the Setup parameters. |

## II.6. Data Acquisition and Display

The Data Display and Acquisition selection in the Main Menu is really the heart of the HT-BHTV software. This portion of the program displays data acquired from the tool, stored in a file, or simulated data calculated by the software. The actual function that this section of the code performs is dependent on the settings of the user-controlled software flags and the operational mode of the software selected by the user. The values of these variables and the resultant operation of the software is summarized in Table II.3 below.

Note: The current version of the software cannot acquire both the acoustic BHTV data and the temperature from the tool at the same time because of time constraints in the software. Consult Section III for further information on the method of data acquisition from the tool. The operations shown in Table II.3 in which the temperature flag is set to True do not, in fact, acquire temperature data from the tool. These operations were included in the table for completeness. Further versions of this software could include the temperature acquisition operation. Section V discusses possible software modifications and advancements. The temperature may be acquired from the tool using a separate computer system and special software. This option is discussed more fully in Section II.8.

The three user-controlled software flags in the table, the Tool, Depth, and Temperature flag variables, are discussed in Section II.3. The mode of operation variable, which has three possible values - TEST, BHTV, and FILE, is discussed in Section II.4. In the table, two adjectives are used which described the type of operation performed. The adjective Simulated means that the software is providing the values for the data. Acquired means that the software is obtaining the values for the data from either the HT-BHTV tool or the depth counter. The last line of Table II.3 gives the operation when the FILE mode of operation is selected. Note that this mode ignores the values of the software flag or else sets the value to False.

When the Data Acquisition/Display item is selected from the Main Menu, the software will display either of two screens on the CRT. When either the TEST or the BHTV mode was selected in the Logging/Data Display Setup Menu, the CRT screen shown in Figure II.21 is displayed. If the FILE mode has been selected then the CRT screen shown in Figure II.22 is displayed. The message displayed on the screen depends upon the File Display option selected in the File Display Menu. If the entire file is to be viewed, then the display shows the message as in Figure II.21: ENTIRE FILE. If only a portion of the file was selected then the display shows the message SELECTED DEPTH INTERVAL if the depth interval option was selected in the File Display Menu or SELECTED RECORD NUMBERS if the record number option was selected. If the depth interval option was selected, the software does a fast binary search to find the record numbers it must display for the depth interval selected. During this

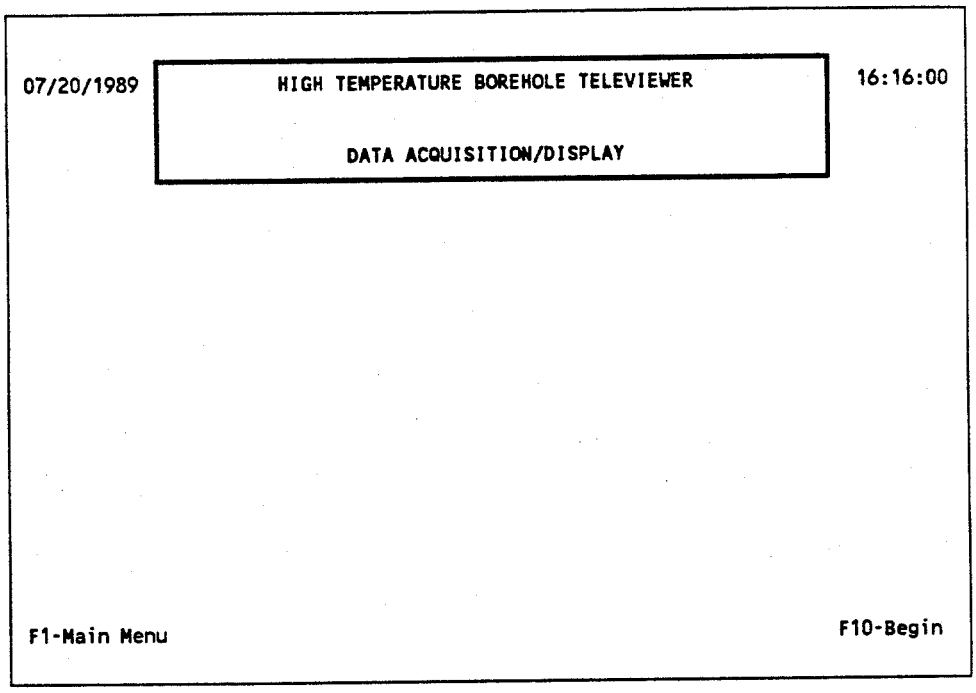


Figure II.21. An example of the CRT screen displayed when the Data Acquisition/Display option is selected in the Main Menu. This example shows the display when the Data Mode variable in the Logging/ Data Display Setup Menu is set to either TEST or BHTV.

search, which should take only a few seconds, the CRT screen will display the message

**Searching for records. Please wait....**

The two function keys displayed on the CRT screen have the following function:

Function key: **F1**
Pressing this key returns the program to the Main Menu.

Function key: **F10**
Pressing this key directs the software to begin the Data Acquisition and Display operation. The functions performed by the software will depend on the values of the Tool Flag and Data Mode variables.

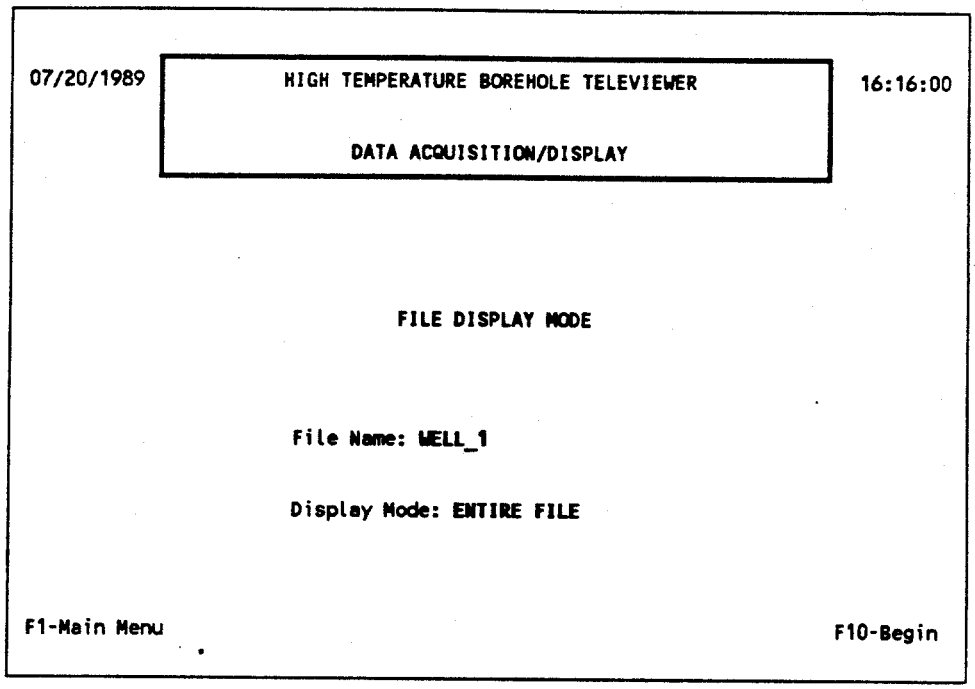


Figure II.22. An example of the CRT screen displayed when the Data Acquisition/Display option is selected in the Main Menu and the Data Mode variable in the Logging /Data Display Setup Menu is set to **FILE**. This example shows the display when the entire file is to be viewed.

### II.6.1. Error Messages

When the Data Acquisition/Display option is selected from the Main menu, the software checks certain conditions and will either display an error message and return to the Main Menu or, in certain situations, transfer the user to the BHTV File Menu. The checks performed by the software pertain to the settings of the Data Mode variable and the type of file currently assigned by the software. If Data Mode is set to **FILE** and no file is assigned, no error message is displayed but the software routes the user to the BHTV File Menu. If Data Mode was set to **FILE** and a **NEW** file was assigned in the BHTV File Menu, the following error message is displayed:

**Cannot access a NEW file in the FILE data mode...**

and the software returns to the Main Menu. If the **BHTV** Data Mode was selected and a **NEW** file was not opened in the BHTV File Menu, then the software displays no error message but routes the user to the BHTV File Menu. However, if

Table II.3. Summary of the possible settings of the user-controlled software flag and operational mode variables and the resultant operation of the software.

| Tool Flag | Depth Flag | Temp. Flag | Data Mode | Operation |
|---|---|---|---|---|
| False | False | False | TEST | Simulated Tool and Depth data displayed |
| False | False | False | BHTV | Simulated Tool and Depth data displayed and stored in user-specified file |
| False | False | True | TEST | Simulated Tool, Depth and Temperature data displayed |
| False | False | True | BHTV | Simulated Tool, Depth and Temperature data displayed and stored in the user-specified file |
| False | True | False | TEST | Simulated Tool data and Acquired Depth displayed |
| False | True | False | BHTV | Simulated Tool data and Acquired Depth displayed and stored in the user-specified file |
| False | True | True | TEST | Simulated Tool and Temperature data and Acquired Depth displayed |
| False | True | True | BHTV | Simulated Tool and Temperature data and Acquired Depth displayed and stored in the user-specified file |
| True | False | False | TEST | Acquired Tool data and simulated Depth displayed |
| True | False | False | BHTV | Acquired Tool data and simulated Depth displayed and stored in the user-specified file |
| True | False | True | TEST | Acquired Tool and Temperature data and simulated depth displayed |
| True | False | True | BHTV | Acquired Tool and Temperature data and simulated depth displayed and stored in the user-specified file |
| True | True | False | TEST | Acquired Tool and Depth data displayed |
| True | True | False | BHTV | Acquired Tool and Depth data displayed and stored in the user-specified file |
| True | True | True | TEST | Acquired Tool, Depth and Temperature data displayed |
| True | True | True | BHTV | Acquired Tool, Depth and Temperature data displayed and stored in the user-specified file |
| ---- | ---- | ---- | FILE | Data stored in user-specified file displayed |

the **BHTV** Data Mode was selected and an **OLD** file was opened in the BHTV File Menu, then the software displays the following error message:

**Cannot access an OLD file in the BHTV data mode...**

and the software returns to the Main Menu. In summary, in either the **BHTV** or the **FILE** Data Modes, it is necessary that a file have been opened in the BHTV File Menu. The software does not allow the user to append data to an existing file, hence, in the **BHTV** mode only a file of type **NEW** is permitted. Conversely, a **NEW** file, by definition, does not have any data stored in it yet so only a file of type **OLD** is allowed when the Data Mode variable is set to **FILE**.

### II.6.2. Description of the CRT Screen for Data Display

Once the Data Acquisition/Display operation is selected by pressing the F10 key, as shown in Figure II.21 or II.22, then the software enters the graphics mode on the CRT screen and begins the operations defined by the current values of the Data Mode and the Flag variables as shown in Table II.3. An example of the Data Display screen shown on the CRT is given in Figure II.23 for the **NORMAL** Display Size mode and in Figure II.24 for the **EXPANDED** Display Size mode. Eight areas of the display are indicated by numbers on the two figures. Some examples of the actual display may be found in Section IV. The eight display areas and their corresponding identification are summarized in Table II.4.

Table II.4. Listing of the eight display sections of the CRT graphics Data Display. Refer to Figures II.23 and II.24 for the positions of these areas on the screen.

| Area No. | Identification |
|---|---|
| 1 | Data Display Area |
| 2 | Depth Annotation Area |
| 3 | Status Display Area |
| 4 | Special Key Display Area |
| 5 | Range/Magnitude Color Code Area |
| 6 | Display Scale Line |
| 7 | Menu Display Line |
| 8 | Message Display Line |

The information displayed in these areas is described below.

#### II.6.2.1. Data Display Area

The Data Display Area graphically shows the data obtained from a file, simulated data calculated by the software, or data acquired by the ADC board following the calculation by the software. The meaning of the colors displayed on the screen are given in the Range/Magnitude Color Code Area. The range information is the arrival time of the return signal having units of microseconds. The magnitude data is the maximum amplitude value of the return signal given in the integer values obtained from the ADC board. The full scale range of this display is ± 2048 corresponding to the selected gain setting on the ADC board. For example, a digitizer gain setting of x1 gives a full scale range of ± 10 volts. The left side of the Data Display corresponds to the Heading Reference indicator from the tool. It is magnetic north when the magnetometer is used and the mark position on the tool for the Mark reference. See Section III for more detailed information on the data display.

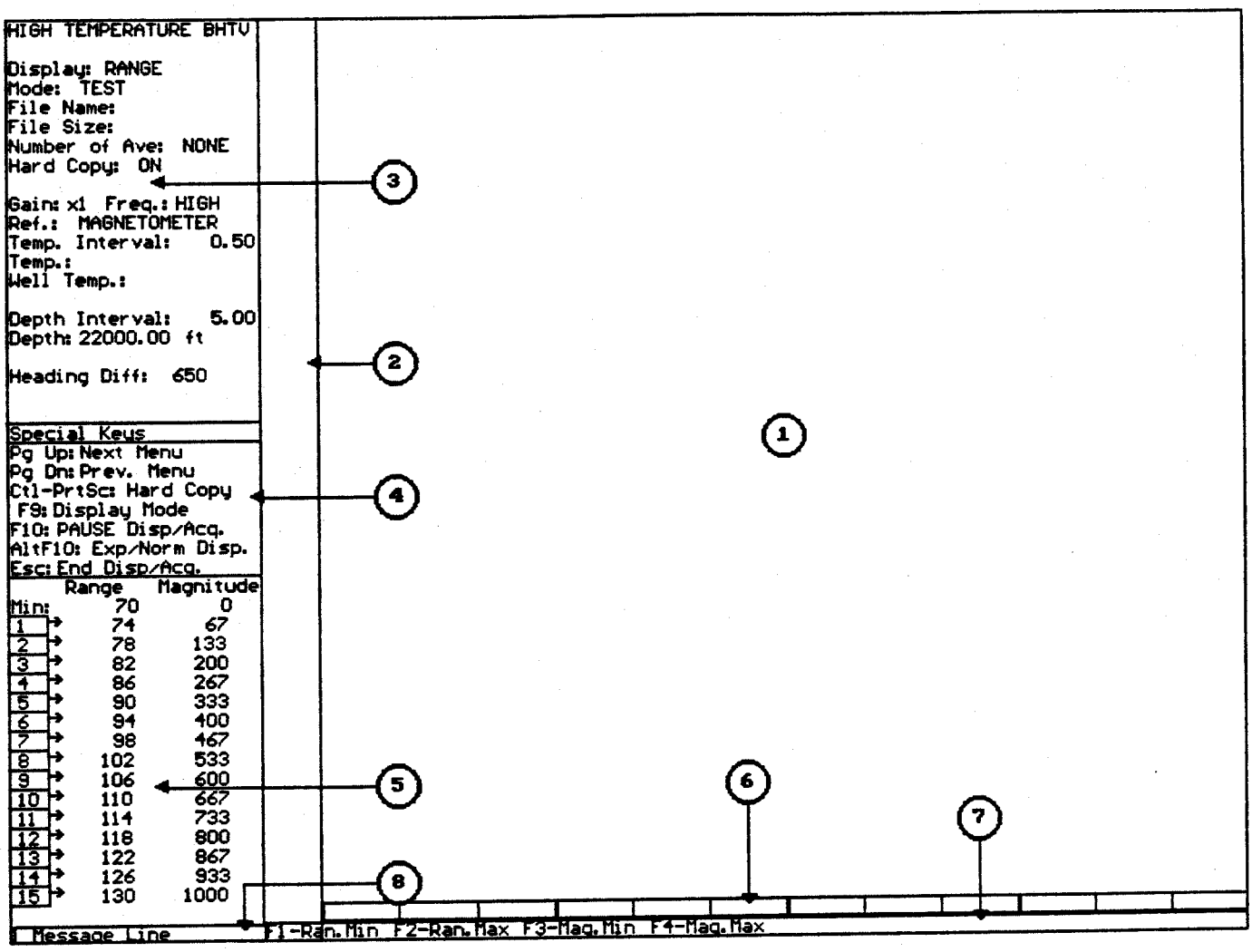


Figure II.23. The Data Display CRT screen for the **NORMAL** Display Size mode. The numbered areas of the display are explained in the text.

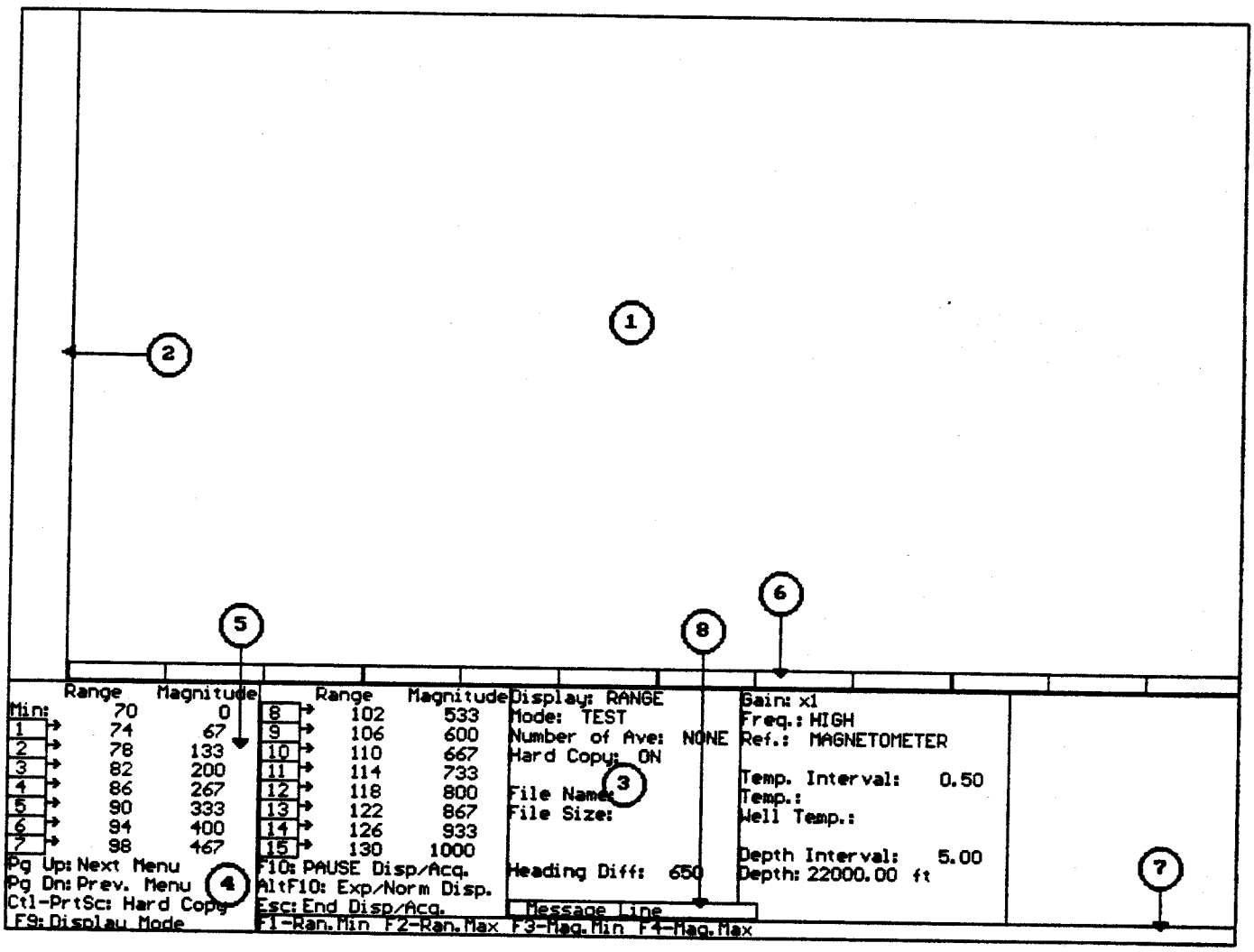


Figure II.24. The Data Display CRT screen for the **EXPANDED** Display Size mode. The numbered areas of the display are explained in the text.

### II.6.2.2. Depth Annotation Area

In this area of the display, the current depth at which the data was obtained is shown. The depth is displayed according to the current value of the Depth Interval which is set in the Logging/Data Display Setup Menu. The value of the depth displayed in this area is truncated since no decimal places are displayed. As noted previously, if the Depth Flag is True, the depth displayed is that acquired from the depth counter. When the Depth Flag is False, the software calculates a depth from an initial depth of 22,000 feet.

### II.6.2.3. Status Display Area

The Status Display Area provides the user with the current settings of some of the important display and tool variables as well as with an update of the depth or the status of the current file if applicable. All the items shown in this display area are described below.

Display Item: **Display**
Function: In this display item, the current value of the Data Mode variable is displayed. Possible values for this variable are: **TEST**, **BHTV**, and **FILE**. See Section II.5.5 for more information.

Display Item: **Mode**
Function: The current value the Data Display Mode variable is shown in this item. The possible values for this variable are: **RANGE**, **MAGNITUDE**, and **RANGE/MAGNITUDE**.

Display Item: **File Name**
Function: In the **BHTV** Data Mode, the file in which all the acquired data are being stored is displayed here. In the **FILE** Data Mode, the name of the file from which the displayed data are taken is shown. In the **TEST** Data Mode, nothing is shown for this display item.

Display Item: **File Size**
Function: In the **BHTV** Data Mode, two values are displayed for the size of the file. The first or leftmost value, shows the record of the virtual disk file in which the most recent displayed line of data was stored. The second value shows the total number of records contained in the data file on the hard disk. As explained more fully in Section III, the software stores the acquired data in a data file on the virtual disk drive labeled E:. This memory area (which is set up when the computer is turned on) contains approximately 11 Mbytes of capacity. This is enough to store 3900

HT-BHTV data records. Hence, the first record value in this display item shows the current record count in the virtual disk file. When this count reaches 3900 records, the software will pause the data collection operation to transfer the data from the virtual disk memory to the hard disk in the BHTVDATA directory. It requires slightly more than 2 minutes to complete this transfer. During the transfer operation, since no data acquisition is occurring, the tool should be stopped in the hole. It is the user's responsibility to watch this display and stop the tool in the hole when the data transfer process begins. The second number will provide the user with an indication of the total number of records which will be stored in the file on the hard disk. The software will allow a maximum value of 15,600 records or 4 complete transfers of the virtual disk file. This is in excess of 40 Mbytes of data storage.

Display Item: **Number of Ave**
Function: The current number of averages performed on the data is shown here. At present, no averaging of the data is permitted.

Display Item: **Hard Copy**
Function: The current setting of the **Hard Copy** variable is shown here. Note that this variable must be set to **ON** to obtain a hard copy printout of the data display. The value of this variable may be changed in the Logging/ Data Display Setup Menu (Section II.5.5) or from one of the Data Display Menus described below.

Display Item: **Gain**
Function: The current Tool Gain value is displayed here. This value may be changed in the Tool Setup Menu (Section II.5.3).

Display Item: **Freq**
Function: The current Tool Transducer Frequency value is displayed here. This value may be changed in the Tool Setup Menu (Section II.5.3).

Display Item: **Ref**
Function: The current Tool Heading Reference value is displayed here. This value may be changed in the Tool Setup Menu (Section II.5.3).

Display Item: **Temp. Interval**
Function: The current setting of the Tool Temperature data acquisition depth interval is displayed here. See Section II.5.5 for more information on this variable.

Display Item: **Temp.**
Function: If the **Temperature Flag is True**, then the heat sink and the electronics temperatures are displayed here. With the **Tool Flag** set to **False**, the software will calculate temperatures to place here. When the Tool **Flag is True**, the temperatures acquired from the HT-BHTV Tool are displayed. Temperatures are displayed in units of degrees C.

Display Item: **Well Temp.**
Function: If the **Temperature Flag is True**, then the well temperature is displayed here. With the **Tool Flag** set to **False**, the software will calculate a temperature to place here. When the **Tool Flag is True**, the well temperature acquired from the HT-BHTV Tool is displayed. The temperature is displayed in units of degrees C.

Display Item: **Depth Interval**
Function: The current value of the depth increment used for the depth annotation on the data display is shown. This value is set in the Logging/Data Display Setup Menu (Section II.5.5).

Display Item: **Depth**
Function: The current depth reading is displayed in this item. If the **Depth Flag is False** then the depth displayed will be the simulated depth calculated by the software beginning at a depth value of 22,000 feet. When the **Depth Flag is True**, the depth displayed here is that obtained from the depth counter.

Display Item: **Heading Difference**
Function: This display item is only present when the HT-BHTV Tool is acquiring data from the ADC board either in the **TEST** or **BHTV** Data Mode. This item shows the difference in sync pulses between the last and current heading pulse found by the software. It is a useful monitor of the performance of both the tool and the software. See Section II.5.4 on the Data Acquisition Menu and Section III for more information on the heading pulse difference.

### II.6.2.4. Special Key Display Area

In this display area, the defined function of certain keys are listed. These special keys (their operation remains the same no matter which menu is currently shown on the CRT screen - see Section II.6.2.7 below) and their function are:

Special Key: **Pg Up**
Function: Pressing this key changes the menu shown on the Menu Display Line (see Section II.6.2.7).

Special Key: **Pg Dn**
Function: Pressing this key changes the menu shown on the Menu Display Line (see Section II.6.2.7).

Special Key: **Ctl-PrtScr**
Function: Pressing this key will direct the software to produce a hard copy of the CRT screen currently displayed. The **Hard Copy** variable must have already been set to **ON** either in the Logging/Data Display Setup Menu or through one of the menus displayed in the menu line on this display. In the **FILE** Data Mode, the user may select a hard copy when the display is updating or when the display has been paused by pressing the F10 special key. In the other two Data Modes, the display must have been paused to obtain a hard copy of this display. The software prints out some information prior to the screen dump. The information printed is shown in Table II.5 for the **FILE** Data Mode. In the **TEST** Data Mode, only the current data and time, and the digitizer board parameters are printed. In the **BHTV** Data Mode, the name of the file and the File Description line are printed in addition to those mentioned for the **TEST** mode.

Special Key: **F9**
Function: Pressing the F9 key changes the value of the Data Display Mode variable. The software toggles through the three available settings of this mode. When the display mode is changed, the data display immediately changes to the current setting of this variable.

Special Key: **F10**
Function: Pressing this key pauses the display and data acquisition process. A message is flashed in the Message Line area informing the user that the display has paused. Pressing any key will resume the operation of the software.

Table II.5. The information displayed when a screen dump is requested of the software. The information shown here is an example of the information displayed in the **FILE** Data Mode.

```
                    HIGH TEMPERATURE BHTV

Date: 08/16/1989                    Time: 15:77:55

File Name: WELL_1                   File Size: 3907 records
Logging Date: 06/08/1989
Log Start Time: 14:47:05.27  Stop Time: 15:12:40.16   Elapsed Time:  0.43 hrs
Log Start Depth:   81.59 ft  Stop Depth:  666.36 ft   Total Depth:  587.77 ft
File Description: HT-BHTV Test in a hot well.

 Digitizer Gain: x1   (+/- 10 volts)
 Sync. Threshold:  -2.441 volts
Range Threshold:   0.977 volts
Range Window - Min: 60 µs           Max: 130 µs
```

Special Key: **AltF10**
Function: This special key changes the size of the display area. In the **NORMAL** Display Size Mode, pressing this key changes the display to the **EXPANDED** Display Size Mode. The CRT screen is cleared, the new screen is set up, and the data is displayed in the new size.

Special Key: **Esc**
Function: Pressing the Escape key directs the software to exit the Data Acquisition/Display operation. In the **FILE** Data Mode, the software pauses the display. Pressing any key at this point will return the user to the Main Menu. In the **BHTV** Data Mode, the software first transfers the data from the virtual disk file to the hard disk. When this operation is complete, the software enters the BHTV File Menu. The user can now add any additional comments to the five lines of comments permitted for each file or add more information to the File Description line. Note that the software has now labeled the data file as an **OLD** file rather then a **NEW** file. The user may now review the data stored in this file, or open another file for additional data storage. No further data may be added to the data file just completed. In the **TEST** Data Mode, the user is returned to the Main Menu.

### II.6.2.5. Range/Magnitude Color Code Area

The Range/Magnitude Color Code area displays the colors on the data display and the resultant value of the Range or Magnitude. The Display Window defined by the Range or Magnitude minimum and maximum values is divided by the fifteen available colors. Black is used for the cases when the data falls outside the data acquisition or the display window. On the display, the value of the Range or the Magnitude shown next to the displayed color defines the end of the interval for that color. All data values which fall in that interval will be displayed in that color. The default color table used in the software is summarized in Table II.6.

Table II.6. The default color table used in the HT-BHTV software. The number of the color refers to the default color palette used in Turbo Pascal Version 4.0. Note that color number 0 is black which is used for data outside of the data acquisition or the display windows.

| Color No. | Color |
|---|---|
| 1 | Blue |
| 2 | Green |
| 3 | Cyan |
| 4 | Red |
| 5 | Magenta |
| 6 | Brown |
| 7 | Light Gray |
| 8 | Dark Gray |
| 9 | Light Blue |
| 10 | Light Green |
| 11 | Light Cyan |
| 12 | Light Red |
| 13 | Light Magenta |
| 14 | Yellow |
| 15 | White |

### II.6.2.6. Display Scale Line

The Scale shown in this area gives an approximate indication of the relative position of the data shown on screen. The left side of the screen is the mark indication or magnetic north depending upon whether the mark or the magnetometer is used in the tool as the heading reference. The lines on the scale are at separations of 30 degrees for either the Range or Magnitude display mode or at 60 degrees for the Range/Magnitude display mode.

### II.6.2.7. Menu Display Line

There are two menus which appear on the Menu Display Line in the data display. When each menu is displayed, the function keys displayed in the menu are programmed to provide the listed operation. The menus are toggled by using either the **Pg Up** or the **Pg Dn** keys. The first menu allows the user to change the values of the Range and Magnitude display windows. The second menu defines two function keys which permit the user to change the value of the Hard Copy variable and to clear the data display. The operation of the function keys defined in the two menus are described below.

**Menu 1**

| | |
|---|---|
| Function key: | F1 |
| Name: | Ran. Min. |
| Operation: | Allows the user to enter a new value for the minimum value of the Range display window. |
| Function key: | F2 |
| Name: | Ran. Max. |
| Operation: | Allows the user to enter a new value for the maximum value of the Range display window. |
| Function key: | F3 |
| Name: | Mag. Min. |
| Operation: | Allows the user to enter a new value for the minimum value of the Magnitude display window. |
| Function key: | F4 |
| Name: | Mag. Min. |
| Operation: | Allows the user to enter a new value for the maximum value of the Magnitude display window. |

**Menu 2**

| | |
|---|---|
| Function key: | F6 |
| Name: | Clear Disp. |
| Operation: | Clears the Data Display Area. |
| Function key: | F7 |
| Name: | Hard Copy |
| Operation: | Toggles the Hard Copy variable. The variable can only be set to ON when the printer is properly connected. |

### II.6.2.8. Message Display Line

The Message Display Line is used to display messages, e.g., when the display has been paused, or for a data input area, as for the Range and Magnitude display windows in Menu 1 described above.

## II.7. Archiving the data to Tape

It is good practice to archive all data taken in the field to tape so that a copy of the data is available if some problem develops with the hard disk. Additionally, the large capacity hard disk on this computer system (available storage of 300 Megabytes) can quickly fill up during a logging operation making it necessary to archive some data to make room for additional acquired data. The computer system comes equipped with an internal 135-Megabyte tape drive. The SY-TOS tape operating system is provided with this drive to backup, verify, and restore televiewer data files. The user should consult the manual for this system [6] for the proper operating procedure. Note: Experience with this tape system and software has shown that the computer must be turned off and back on before using the tape system if the computer system was used to acquire televiewer data from the HT-BHTV tool.

## II.8. Temperature Acquisition Program

Because of the rather severe time limitations in the system for data acquisition, display, and storage during a logging operation, the software is not capable of acquiring temperature data. Since temperature data is considered important, especially as a tool diagnostic (cf. Section IV), a separate program is provided, for use on another computer system, to acquire and store the temperature data from the tool. This program may be started by typing BHTV_DEG at the C> prompt. The program asks for the name of a file in which to store the data. Once the program is started, temperatures are acquired at a 500 ms interval. The resultant file will contain the time and temperatures but no depth information. This file may be correlated with the tool data file (.BTV extension) to add the proper depth to the temperature data.

# III. TECHNICAL DESCRIPTION OF SOFTWARE

The HT-BHTV software was written in Turbo Pascal Version 4.0 [7,8,9,10, 11]. Included in the software package for this tool is additional software for the operation of the Metrabyte Data Acquisition Board for the computer. Turbo Pascal Version 4.0 allows a programming construct called a **unit**. Each unit is a self-contained program consisting of a set of procedures and functions. Selected procedures and functions in the unit may be called by another program or unit if these procedures are first defined in the *interface* section of the unit. Another section of the unit, called the *implementation* section, contains all the procedures and functions required by the unit but not accessible by other programs or units. The use of the unit in this language allows the programmer the flexibility to separate the operations of the software into these separate sections which can be compiled and debugged independently from other parts of the code. The HT-BHTV software has used the unit concept to build modular program sections for the separate menus and operations of the program.

There are 41 files contained in the HT-BHTV software package. Of these, two files, a source listing and an executable binary, are for the main program. Two are text files specifying the path name for the BHTVDATA directory and the virtual disk. Three are files associated with the Metrabyte Data Acquisition board. One file is an *Include File* for a unit. There are three batch files for starting the program or initializing the data acquisition system. The separate temperature acquisition program is contained in an executable binary and source listing file. The remaining 26 files comprise the bulk of the software. These are the 13 units in the software. Each unit has a source listing file using the extension .PAS and a precompiled unit file with the extension .TPU. These files are summarized in Table III.1.

A schematic diagram of the hardware and connections for the HT-BHTV tool and the computer system is shown in Figure III.1. The hardware requirements of this system are summarized in Appendix A. In this section, technical information regarding the operation of some parts of the HT-BHTV software is presented. In particular, the software interface with the depth counter, televiewer, ADC board, and printer are discussed. Certain important aspects of the software, including the file format and data display, are also discussed.

## III.1. Tool Parameters

Control commands are sent and temperature data are received from the HT-BHTV tool through the Surface Unit over a 300 bps RS-232 serial line connected to the COM2 port on the computer. The serial interface is configured for 300 baud, no parity, 2 stop bits, and 8 data bits. Table III.2 summarizes some useful information on IBM PC compatible serial ports. Commands are sent to the tool by a coded byte (8 bits) sent over the serial line. Note that only a single byte is sent. No end-of-line terminators, such as a line feed

Table III.1. Listing of the HT-BHTV software files. The units or programs shown below also require the following Turbo Pascal standard units: Dos, Crt, Graph, and Printer; and the following graphics files: EGAVGA.BGI and LITT.CHR. In the table, the heading labeled Note contains numbers with the following definition:

1 - Unit containing a menu and associated procedures;
2 - Unit containing data acquisition/display procedures;
3 - Unit containing misc. utility procedures.

| Unit Name | File Name | File Ext. | Note | Function |
|---|---|---|---|---|
| BHTV_MAIN | BHTVMAIN | EXE/PAS | - | Main program. |
| Tool_Status | TOOLSTAT | TPU/PAS | 1 | Tool Setup Menu + associated procedures |
| DigitizeBHTV | DIGBHTV | TPU/PAS | 1 | Data Acquisition Menu |
| DepthCounter | DEPTHENC | TPU/PAS | 1 | Depth Encoder Setup Menu + associated procedures |
| LoggingSetup | LOGSETUP | TPU/PAS | 1 | Logging/Data Display Setup Menu + associated procedures |
| DataFiles | DATAFILE | TPU/PAS | 1 | BHTV File Menu + associated procedures |
| FileDisplay | FILEDISP | TPU/PAS | 1 | File Display Menu + associated procedures |
| TestParameters | TESTPARM | TPU/PAS | 1 | Test Paramater/File Setup Menu |
| Data_Acq_Display | DATA_ACQ | TPU/PAS | 2 | Data Acquisition from tool using ADC board |
| NA | DATADISP | PAS | 2 | Include file for the DATA_ACQ unit;data display procedures |
| BHTV_data | BHTVDATA | TPU/PAS | 2 | Procedures for calculation of simulated tool data |
| PrintData | PRNTDATA | TPU/PAS | 2 | Procedures for printing the CRT on color printer |
| TextWindow | WINDOW | TPU/PAS | 3 | Windowing procudures; used for data input + error messages |
| FileCopy | FILECOPY | TPU/PAS | 3 | Procudure for copying files; used to copy waveform data |
| UtilitiesLibrary | UTIL_LIB | TPU/PAS | 3 | Misc. string, CRT screen, and keyboard procedures |
| DAS20EXT | DAS20EXT | TPU | 2 | Metrabyte-supplied unit |
| tp4d20 | TP4D20 | TPU | 2 | Metrabyte-supplied unit; data acquisition procedures |
| NA | DAS20_0 | OBJ | - | Object file with assembly language procs. for ADC board |
| NA | BHTVPATH | TXT | - | Text file containing path name for BHTVDATA directory |
| NA | VDISK | TXT | - | Text file containing path name of virtual disk |
| NA | HTBHTV | BAT | - | Batch file for starting HT-BHTV program |
| NA | BHTVINIT | BAT/EXE/PAS | - | Batch,binary,source file for initial. system for ADC board |
| NA | BHTV_DEG | BAT/EXE/PAS | - | Batch, binary, source file for temperature acq. program |

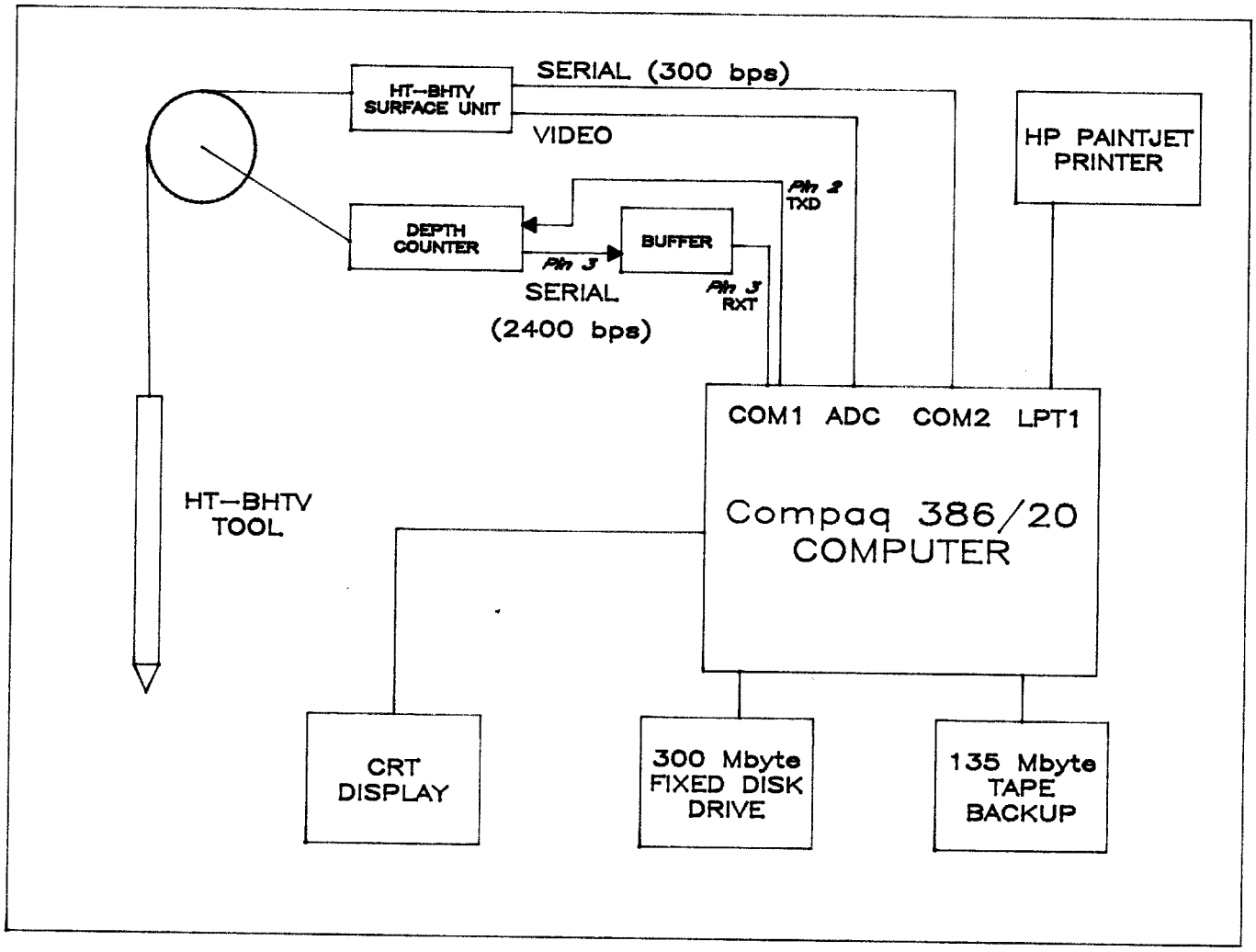


Figure III.1. Schematic diagram of the interconnection of the hardware required for the HT-BHTV system at the surface. A special serial connection is required for the depth counter system. The TXD line is for transmitted data, DTE to DCE; the RXT line is for received data, DCE to DTE. For the counter-to-buffer connection, the following pins on the serial line are tied together: pin 5 (CTS), pin 6 (DSR), pin 8 (DCD), and pin 20 (DTR).

Table III.2. Summary of some useful addresses for the INS8250 UART used on IBM PC compatible computers [12] (Note: Compaq computers use a National Semiconductor NS16450 Asynchronous Communication Element; both of these uarts use the same addresses). The addresses listed below are given in hexadecimal units.

| Register | Address COM1/COM2 | Description |
|---|---|---|
| Receive Buffer | $3F8/$2F8 | Read only register containing most recently received byte from the computer. |
| Line Status | $3FD/$2FD | Information on the status of the data transfer. Bit 0 indicates that data is ready to be received. |
| Modem Control | $3FC/$2FC | Bit 0: Data Terminal ready; computer is ready to communicate with the device.<br>Bit 1: Request to Send (RTS). |

and/or carriage return, are sent to the tool. Sending such additional data to the tool causes unforeseen results and could result in the tool locking up. Table III.3 summarizes the commands and the byte patterns used.

The tool sends to the computer the requested temperature information as either one or two bytes. The electronics and the heat sink temperature have a resolution of 8 bits while the well fluid temperature has a resolution of 12 bits. Hence, the tool requires two commands to return the complete well temperature. Each of the commands returns one byte of this temperature. Following the return of the temperature information, the software calculates the temperature in degrees Celsius using the following equation for the electronics and heat sink temperatures:

$$\text{Temperature in } ^\circ\text{C} = 1.953125 * \text{byte} - 273.15;$$

and the equation below for the conversion of the well fluid temperature data:

$$\text{Temperature in } ^\circ\text{C} = k_0 + k_1 * n + k_2 * n^2 + k_3 n^3 + k_4 * n^4 + k_5 * n^5,$$

where

$$n = (\text{High byte}) * 256 + \text{Low byte};$$
$$k_0 = 288.1888;$$
$$k_1 = -0.1480216;$$
$$k_2 = 3.767929 \times 10^{-5};$$
$$k_3 = -7.876804 \times 10^{-9};$$
$$k_4 = 1.064097 \times 10^{-12};$$
$$k_5 = -6.423687 \times 10^{-17}.$$

Table III.3. Command byte sent to the HT-BHTV tool by the computer. The letter x denotes bit positions that are not used and ignored by the tool. The letter b denotes bit positions defined by the current setting of another function. For example, the command byte for the low transducer frequency must contain the current setting of the heading reference in bit position 1. Note that only the gain commands have bit 7 set to 0; all other tool commands require that bit 7 have a value of 1.

| Function | Command Byte 7 6 5 4 3 2 1 0 |
|---|---|
| Gain - x1 | 0 x x x x x 0 0 |
| Gain - x10 | 0 x x x x x 1 0 |
| Gain - x50 | 0 x x x x x 1 1 |
| Freq. - High | 1 x x 0 0 0 b 0 |
| Freq. - Low | 1 x x 0 0 0 b 1 |
| Heading - Mag. | 1 x x 0 0 0 0 b |
| Heading - Mark | 1 x x 0 0 0 1 b |
| Temp. - Sink | 1 x x 1 0 0 b b |
| Temp. - Elect. | 1 x x 1 0 1 b b |
| Temp.-Well-Low | 1 x x 0 1 0 b b |
| Temp.-Well-High | 1 x x 0 1 1 b b |

The term byte refers to the decimal representation of the data byte returned by the tool.

## III.2. Depth Counter

The HT-BHTV software is designed to operate with a Red Lion Controls Gemini 2000 Counter which in turn is connected to a Red Lion Controls Rotary Pulse Generator model RGPC-46-1-0500 (500 pulses per revolution) optical encoder attached to the cable or the cable drum axle. The counter is connected to the computer at the COM 1 port over a 2400 bps RS-232 serial line through a Red Lion Controls Model GCM232 Serial Converter Module. Because of time constraints in the software and the approximately 100 ms internal conversion time of the counter, the serial line to the computer from the counter is configured as shown in Figure III.1. The output from the counter is fed into a serial buffer while the input to the counter from the computer bypasses this buffer. This allows the computer to send the *request depth* command to the counter and the resultant depth from the counter is stored in the buffer until the computer requests this stored depth. As indicated above, there is a 100 ms delay from the time the computer sends the command for the depth to the

counter and the time the computer receives the depth from the counter. During data acquisition, the acoustic transducer in the tool is rotating at a rate of 333 ms/rotation. During this time, the software must acquire the digitized data, perform the necessary calculations, display and store the data. The system cannot afford a delay of 100 ms while waiting for the depth data from the counter. For this reason, the buffer was set up to hold this data until the computer requests it. The serial interface is configured for 2400 baud, 1 start bit, 1 odd parity bit, 1 stop bit, and 7 data bits. The commands sent to the counter and the format of the data returned by the counter are summarized in Table III.4.

Table III.4. Summary of Depth Counter commands. The asterisk, *, is the command delimiter for commands sent to the counter. The depth preset value and the depth value itself depend on the number of decimal places set in the counter. Possible values are 0, 1, and 2. The formats shown in the table assume that 2 decimal places have been selected. The number of decimal places shown on the counter cannot be changed by software but only by the front panel controls of the counter. See the manual for the counter for further information. NA indicates places where a response is *not applicable*. The letter *b* refers to numerical values returned or sent to the counter.

| Command | Data Format | Type of Command |
|---|---|---|
| R* | NA | Counter reset |
| TC* | ±bbbb.bb | Counter transmits depth to computer |
| TD* | ±b.bbbb | Counter transmits scale factor to computer |
| TB* | bbbb.bb | Counter transmits preset value to computer |
| VBbbbb.bb* | NA | Computer sends new preset value to the counter |
| VD±b.bbbb* | NA | Computer sends new scale factor to the counter |

## III.3. Data File Format

The HT-BHTV software stores selected data from its operation into one of six file types all of which are stored in the BHTVDATA subdirectory on the hard disk. Each of the files created by the program are typed or random-access files. There are four files storing data and information during a logging operation. Waveform data and setup information each have a single file associated with them.

### III.3.1. Televiewer Data Files

The four files which result from a logging operation are denoted by the particular extension assigned by the software. The information stored in each record of these four files is summarized in Table III.5.

Table III.5. Summary of information contained in each individual record of the four televiewer data files.

| File Ext. | Record Element Name | Record Element Type | Record Size |
|---|---|---|---|
| BTV | Depth<br>Time<br>Range<br>Magnitude | real<br>string[11]<br>array[1..650] of integer<br>array[1..650] of integer | 2616 bytes |
| LOG | Date<br>StartTime<br>StopTime<br>StartDepth<br>StopDepth<br>Description<br>Comments | string[10]<br>string[11]<br>string[11]<br>real<br>real<br>string[60]<br>array[1..5] of string[78] | 499 bytes |
| DEG | Depth<br>Time<br>WellLow<br>WellHigh<br>ElectTemp<br>SinkTemp | real<br>string[11]<br>byte<br>byte<br>byte<br>byte | 20 bytes |
| CTL | Depth<br>Time<br>Gain<br>Freq<br>Ref<br>DigitizerGain<br>syncThreshold<br>RangeThreshold<br>RangeWindowMin<br>RangeWindowMax | real<br>string[11]<br>x1,x10,x50<br>High,Low<br>Magnetometer,Mark<br>x1,x2,x20,x200<br>integer<br>integer<br>integer<br>integer | 28 bytes |

Files with the .BTV extension contain the time, depth, and the data arrays in each separate record. There are two data arrays stored in each record. One array contains the magnitude or amplitude data extracted from the digitized waveforms obtained from the tool. The other array contains the range or time interval data. Section III.4 discusses the method used by the software to construct these data arrays from the digitized waveform. Each array contains 650 elements (which is approximately equal to the number of tool pulses during a single rotation of the transducers at a rate of 3 rps) stored in integer format. Each record in this file corresponds to a single horizontal line of data displayed on the CRT screen.

Files with the .DEG extension contain the temperature data acquired from the tool during a logging run. Each record corresponds to a separate temperature acquisition from the tool. If a second computer system was used for this data acquisition (cf. Section II.8), no depth information is stored in this file. However, the stored data acquisition times in the .BTV and .DEG files

may be correlated and the correct depths can be added to the .DEG file. This exercise is left to the user.

Files with the .LOG extension contain information from the logging run. These files consist of a single record unlike the .BTV and .DEG files. The information in this file is entered and displayed in the BHTV File Menu.

Finally, files with the .CTL extension contain information on the data acquisition setup used for the tool and the ADC board. This file also consists of a single record.

### III.3.2. Waveform Data Files

Digitized waveforms, acquired using the Data Acquisition Menu (cf. Section II.5.4), are stored in waveform data files in the BHTVDATA directory with the file extension .WAV. These are large files containing 640,000 bytes of data. The data are stored in an integer format, hence, 320,000 data samples are stored in each file. Since there are roughly 51 data samples for each video frame, these files store the equivalent of 6,274 video frames or about 9.6 rotations of the televiewer transducers. No additional information is stored in these files.

### III.3.3. Data Acquisition Setup Files

The Data Acquisition Setup Files store data pertinent to data acquisition from the tool and the display of the data on the CRT screen. Section II.5.8 on the Test Parameter/Setup File Menu discusses the operation of storing and reading the information contained in these files. The files contain a single record having a size of 36 bytes. The names of the individual components of the data record and their data type are summarized in Table III.6.

Table III.6. Summary of information contained in the Setup Files stored and read by the Test Parameter/Setup File Menu.

| Record Element Name | Record Element Type |
|---|---|
| DigitizerGain | x1,x2,x20,x200 |
| syncThreshold | integer |
| RangeThreshold | integer |
| RangeWindowMin | integer |
| RangeWindowMax | integer |
| RangeMin | integer |
| RangeMax | integer |
| MagMin | integer |
| MagMax | integer |

## III.4. Data Acquisition Using the Internal ADC Board

The HT-BHTV software uses a Metrabyte Corp. model DAS-20 High Performance Analog and Digital Interface Board having 12 bit resolution and a maximum conversion rate of 100,000 samples/second to digitize the waveform returned from the televiewer [15]. This analog-to-digital converter board (ADC) operates in a background mode writing the digitized data to computer memory using a Direct Memory Access (DMA) channel [14]. The software uses the following three procedures from the tp4d20 unit [16]:

**GetDMABuffer:** allocates memory on the Turbo Pascal heap and returns a pointer to the starting address of the buffer; buffer size set to 64,000 bytes.

**DAS20Mode0:** initializes the DAS-20 system; sets interrupt level to 7 and the DMA level to 1.

**d20Ainsc:** scans the analog input channels (channels 0 and 1 are used) and stores the result in the DMA buffer; set to continuous operation; takes 32,000 samples at a rate of 100,000 samples per second.

The DMA channel is limited to 64 kbytes or 32 kbytes of data samples. Because of this limitation, the software uses the concept of a double buffer to access the data stored in RAM from the ADC board. Two buffers, contiguous in memory, set to a size of 32,000 bytes or 16,000 data samples, are defined by the software. (Both the DATA_ACQ and DIGBHTV units employ this concept.) As the ADC board writes to one buffer, the software is checking (or, in the case of the DIGBHTV unit, storing to virtual disk) the data in the other buffer.

The ADC board digitizes the televiewer data at a rate of 100,000 samples per second which yields a time resolution of 10 $\mu$s. A better time resolution than this value is really desired for the range or arrival time. However, the bus used on the IBM compatible systems tends to limit the maximum digitizing rate due to the limitation on data transfer through a DMA channel. To improve the time resolution of the system, the software uses a linear interpolation scheme to provide time intervals less than 10 $\mu$s. In this scheme, the data samples on either side of the sync and range threshold values (cf. Figure II.7) are used, together with the threshold values, to calculate a time with a resolution of 1 $\mu$s. In this technique, the principle assumption is that the data signal can be approximated as a linear response over the 10 $\mu$s interval defined by the two points which bound the threshold values. Tests using this interpolation scheme have shown an improvement in the time resolution of the range information. However, future improvements to this system should include the incorporation of a faster digitizing board to reduce any potential error in the interpolation method used in the software.

The magnitude or amplitude data is found using a relatively simple method. The software determines the maximum value of the first 4 data samples which exceed the Range Threshold level (cf. Figure II.7). This maximum value is then stored as the amplitude value. No interpolation is used to improve the amplitude resolution here because, unlike the case for the range value, a linear approximation is very likely not valid. Some knowledge of the signal shape is required to give a reasonable interpolated value. However, any calculation using an estimated signal shape may require too much time for the system and cause a loss of the heading pulse signal.

If the return signal from the wall of the borehole falls below the value of the range threshold level or falls outside of the range window time interval (cf. Figure II.7), the software will store a value of 0 for both the range and magnitude data. A value of 0 is displayed as no color or black on both the CRT screen and the hard copy display. The user must adjust either the range threshold value or the limits of the range window if a signal is desired.

The data for both the range and magnitude arrays are stored in integer format (integers require 2 bytes or 16 bits; the ADC board used for the digitization has an amplitude resolution of 12 bits). The range information is stored in units of microseconds with a resolution of 1 $\mu$s. The magnitude data are stored as integer values in the range of ±2048. The data are modified from the bit-shifted form received from the ADC board [15]. Storing the data in this format means that the setting of the gain on the board is not used. The actual voltage value depends on this gain setting. See Section II.5.4 for the voltage ranges corresponding to the different gain settings.

Occasionally, some operation in the computer, either I/O related or computational, will require a slightly longer time to complete. When this happens, the Heading Difference display on the CRT screen will show a value substantially different than the normal difference value displayed. This *"loss of synchronization"* in the software will cause perhaps 1 or 2 data lines on the CRT screen to be displaced from the other data lines shown. With the double buffer used for the calculations, the data should be quickly *"synchronized"* again. However, if this problem becomes quite regular, this means that the Range Window Time Interval is probably too long and should be shortened.

## III.5. Data Display

The graphics display in the VGA mode used in this software has 640 horizontal and 480 vertical pixels. The actual display area for the data (see Figures II.23 and II.24) is less than this because of the additional information shown on the CRT screen. In the **NORMAL** display mode, the data display area consists of 480 horizontal and 460 vertical pixels. In the **EXPANDED** display mode, the data display area consists of 610 horizontal and 340 vertical pixels. When both the range and magnitude data are displayed simultaneously, the number of horizontal pixels for each is reduced to 238 for the

**NORMAL** display mode and to 303 for the **EXPANDED** display mode. (Note: this discussion assumes that the tool rotational speed is set to 3 rps; the other tool rotational speeds will have correspondingly different numbers of horizontal pixels.) The range and magnitude data arrays each contain 650 elements. Obviously, these data must be reduced in some manner to permit a display of less than all the data. This is accomplished using a linear decimation algorithm [13]. This algorithm deletes samples and does a linear interpolation to provide values between data samples as required. These new samples are checked to see if they fall outside the range window time interval in the case of the range data. Those samples which are outside this window are assigned a value of 0.

Following the data decimation, the data are checked to determine in which color interval they fall. The color intervals are displayed on the CRT screen and can be adjusted by changing the values of the Range or Magnitude display windows. Any change to these limits causes the software to display the new color intervals. Once the appropriate color interval is found, the pixel corresponding to the decimated data sample is assigned the color of that interval. This display has 16 possible colors (see Table II.6) which may be used with the color black reserved for the case when the data value falls outside of the Range Display or the Data Display windows.

### III.6. Hard Copy Output of CRT Screen

A color hard copy of the CRT screen (for both the televiewer Range/Magnitude display and the digitized waveform data display) is obtained using a Hewlett Packard PaintJet printer. This printer has a palette of 330 colors and a resolution 90 dpi. The printer is connected to the computer using a standard parallel interface. The complete screen dump to the printer requires slightly more than two minutes.

When a hard copy of the CRT screen is requested, the software reads the color of each pixel on the screen ( a total of 307,200 pixels for the VGA graphics mode) beginning at the top left and proceeding horizontally across the screen. The color of each pixel is converted to the appropriate printer color using the conversion table shown in Table III.7. The data are converted to characters which are sent to the printer. Each one-byte character defines the color of eight pixels. For the 16 colors listed in the table, four passes are required to define the correct color to the printer.

Table III.7. Conversion table used in the software to convert the CRT screen color to a PaintJet printer color. The Row,Column heading in the table refers to the row and column numbers on the printer's color spectrum [17].

| CRT Screen Color | PaintJet Palette Index Number | Row,Column |
|---|---|---|
| Black | 0 | 33,7 |
| Blue | 4 | 31,3 |
| Green | 2 | 17,2 |
| Cyan | 6 | 29,1 |
| Red | 1 | 11,8 |
| Magenta | 5 | 9,7 |
| Brown | 9 | 13,10 |
| Light Gray | 11 | 33,9 |
| Dark Gray | 10 | 33,8 |
| Light Blue | 13 | 29,3 |
| Light Green | 14 | 16,2 |
| Light Cyan | 8 | 29,4 |
| Light Red | 12 | 11,1 |
| Light Magenta | 7 | 9,10 |
| Yellow | 3 | 15,4 |
| White | 15 | 33,10 |

## IV. FIELD TESTS OF THE HT-BHTV TOOL

Two field tests were made to test the HT-BHTV system. While these tests were to check the performance of the software, electronics, and the mechanical section of the tool, this section will stress the execution of the software in a field environment. The first test was conducted during the week of April 3, 1989 in the Baca-3 well located in the Valles Caldera in northern New Mexico. The second test of the system was conducted in two Unocal Geothermal wells located in the Salton Sea Known Geothermal Area in southern California during the week of June 5, 1989. The performance of the tool, paying particular regard to the software, is described for these two tests. Results are presented from the test in the Salton Sea area.

### IV.1. Baca-3 Well Test

The Baca-3 well presented a relatively benign environment in which to test the HT-BHTV system. The maximum temperature encountered by the tool was about 155°C. Table IV.1 summarizes the data that was stored during this test. The logging rate was 5 ft/min for the first two files shown in the table and was 10 ft/min for the last file.

Table IV.1. Summary of the data recorded during the Baca-3 well test of the HT-BHTV system.

| File Name | Start Depth (ft) | Stop Depth (ft) | Logged Depth (ft) | Logging Time (hrs) | No. Records |
|---|---|---|---|---|---|
| BACA001 | 1889.64 | 1780.05 | 109.59 | 0.35 | 3739 |
| BACA002 | 1010.10 | 899.99 | 110.11 | 0.36 | 3907 |
| BACA003 | 879.95 | 659.48 | 184.47 | 0.32 | 3312 |
| Totals: | | | 404.17 | 1.03 | 10958 |

The purpose of the field tests was to flush out any problems that would develop in an actual fielding environment that did not materialize in the laboratory testing of the tool. In this test, we found that the software did not catch all the depth values from the counter. In fact, there were long periods when no new depth was transferred from the counter. This problem developed from a combination of the long conversion time in the counter and the longer computational time required by the software for some of the ac-

quired data. This difficulty forced us to develop the buffer system for the depth counter which was described in the previous section. The range data from the televiewer showed some places where the casing in the hole was either badly corroded or scaled or showed the buildup of a mud cake.

## IV.2. Salton Sea Well Tests

For the Salton Sea well tests, a more complete software package was available than that used in the Baca-3 test. The software now included the buffer system for the depth counter but did not include the algorithm for obtaining the amplitude information from the digitized waveform. Rather, the range information obtained from the digitized waveform was stored in both the Range and the Magnitude arrays.

The BHTV tool was operated in two Unocal wells: IID-11 and Sinclair-22. The first well we entered was Sinclair-22. Our plan was to lower the tool to a depth having a high temperature and to log up the hole. As the tool was lowered down the well, at a velocity of 50 ft/min, data from the tool was displayed but, unfortunately, not stored on the hard disk. The data clearly showed the casing joints or collars at about 40 ft intervals. At a depth of 3000 ft, we were stationary for perhaps 30 to 60 minutes as we prepared to begin the log. When we again monitored the temperature of the BHTV tool, we noticed that the heat sink temperature was about 30 degrees C higher than the electronics temperature. Also at this time we found that the tool would no longer rotate. We immediately began to pull the tool out of the hole. During this period, we saw both the heat sink and electronics temperature inside the tool increase. The heat sink temperature rose to a maximum value of 117°C while the electronics temperature maximum was 74°C. Upon removal of the tool from the well, we discovered that the teflon window had collapsed around the transducer and that a bulkhead seal had failed causing the hot oil from the mechanical section of the tool to enter the electronics section. This produced the large temperature differential between the heat sink and electronics temperature sensors. The oil had to be completely removed from the electronics before continuing with the logging operation.

These results demonstrate the usefulness of the two internal temperatures in the HT-BHTV tool. Obviously, a single internal temperature would give an indication when the temperature in the tool is getting too high for the proper functioning of the electronics. But the two internal temperatures provide a rather unique diagnostic of a seal failure as shown above. We knew at the time that there existed a problem in the tool. However, we did not realize at the time that both the heat sink and the electronics temperatures were correct. These temperatures gave us a warning of the failure of the seal on the tool.

Following the resolution of these problems, we moved to the IID-11 well. This well was logged following a caliper log performed by a commercial logging company. The scale buildup in this well had reduced its size from a nominal

seven inches to between 5.5 to 5.75 inches. At this small diameter, it was difficult to obtain a good response from the transducer because of the interference with the blanking of the boot pulse (cf Figure II.7). However, a substantial amount of data was recorded. The data recorded here and in the Sinclair-22 well are summarized in Table IV.2. The software behaved well for most of the logging operation with only minor problems developing. One of the problems involved the temporary storage of the data on the virtual disk of the computer. Most of the memory became inaccessible to the software for data storage. The problem was solved by erasing the temporary file created before data was stored to a new file. Later analysis of this problem showed that the file on the virtual disk was not *closed* before the new data was written to it. The data from this well showed little in the way of features though playback of the data did show a correlation between this data and the caliper log of the well.

The following day we returned to the Sinclair-22 well. The complete set of data recorded in this well is summarized in Table IV.2. We obtained a substantial amount of data from this well with only minor problems from either

Table IV.2. Summary of the data recorded during the Salton Sea test of the High Temperature Borehole Televiewer. The data required more than 198 million bytes of storage.

| File Name | Start Depth (ft) | Stop Depth (ft) | Logged Depth (ft) | Logging Time (hrs) | No. Records |
|---|---|---|---|---|---|
| IID11_A | 81.59 | 666.36 | 584.77 | 0.43 | 3907 |
| IID11_B | 666.55 | 2600.39 | 1933.84 | 1.45 | 12953 |
| IID11_C | 2503.79 | 2397.01 | 106.78 | 0.39 | 3389 |
| IID11_D | 799.97 | 460.87 | 339.10 | 1.22 | 9862 |
| SINC22_A | 196.47 | 4003.51 | 3807.04 | 0.94 | 5950 |
| SINC22_B | 4037.77 | 3903.13 | 134.64 | 0.46 | 4057 |
| SINC22_C | 5530.04 | 5359.93 | 170.11 | 0.35 | 1217 |
| SINC22_D | 5360.02 | 5437.45 | 77.43 | 0.34 | 2489 |
| SINC22_E | 5401.08 | 4697.53 | 703.55 | 2.34 | 15601 |
| SINC22_F | 4697.39 | 4353.77 | 343.62 | 1.13 | 7801 |
| SINC22_G | 4211.89 | 3799.95 | 411.94 | 1.01 | 8624 |
| Totals: | | | 4805.78 | 10.06 | 75850 |

the electronics or the software. However, we did lose the well temperature after traversing the high temperature region of the well and eventually we did lose all the temperatures from the tool. The well temperature was lost because the sensor was disconnected inside the tool. The loss of the other temperatures was caused by the failure of one of the lines in the logging cable. The data showed many features of interest especially several fractures in the open hole section of the well. Problems developed, however, with the mechanical section of the tool. In several instances, the tool rotation would stop only to restart at a later time. Increasing the motor current would sometimes cause the rotation to return. When the tool did not rotate, the software did not acquire or store any data from the tool. Note that the problem with the tool rotation did not start until after the tool passed through the high temperature zone.

The data obtained from the open hole section of the Sinclair-22 well showed many features having structures expected of fractures or breakouts. Figure IV.1 shows data near 5380 ft which illustrates the sinusoidal pattern of a fracture intersecting the wellbore at some angle. One section of the fracture appears to be open which is shown by the black area on the figure. Figure IV.2 shows another feature resembling a fracture at a depth near 5418 ft. In this figure a dual display showing both the range and magnitude data is illustrated. Recall that the magnitude algorithm was not incorporated into the software for this test; both the range and magnitude displays in this and the next figure show only the range data. This figure demonstrates how adjusting the display window can highlight certain features in the data. In the magnitude display (the right display in the figure), the display window was adjusted so that only a single color is shown. Some of the features of the fracture are clearer than in the standard range display. Finally, Figure IV.3 illustrates a unique feature of this display system. Shown here is a possible breakout at a depth of 5342 ft. The magnitude display on the left shows the data as it would appear when the display window is set to the same values as the range window. The green stripes are due to 60 Hz noise picked up by the cable. The range display on the right shows the effect of adjusting the minimum value of the display window to 80 $\mu$s rather than 70 $\mu$s. The noise disturbing the breakout pattern has been removed showing that the display window can be used to filter the data returned by the tool.

The field tests of the HT-BHTV tool exercised the software and pointed out problems requiring correction. The tool was tested in a particularly harsh environment in the Salton Sea wells and, except for the failure of a mechanical section, performed well. A large amount of data was obtained using the software. This data can now be replayed and studied in more detail than is possible during the logging operation. However, many features were viewed during the log and this demonstrates the usefulness of the real time display of the data during the log of a well.

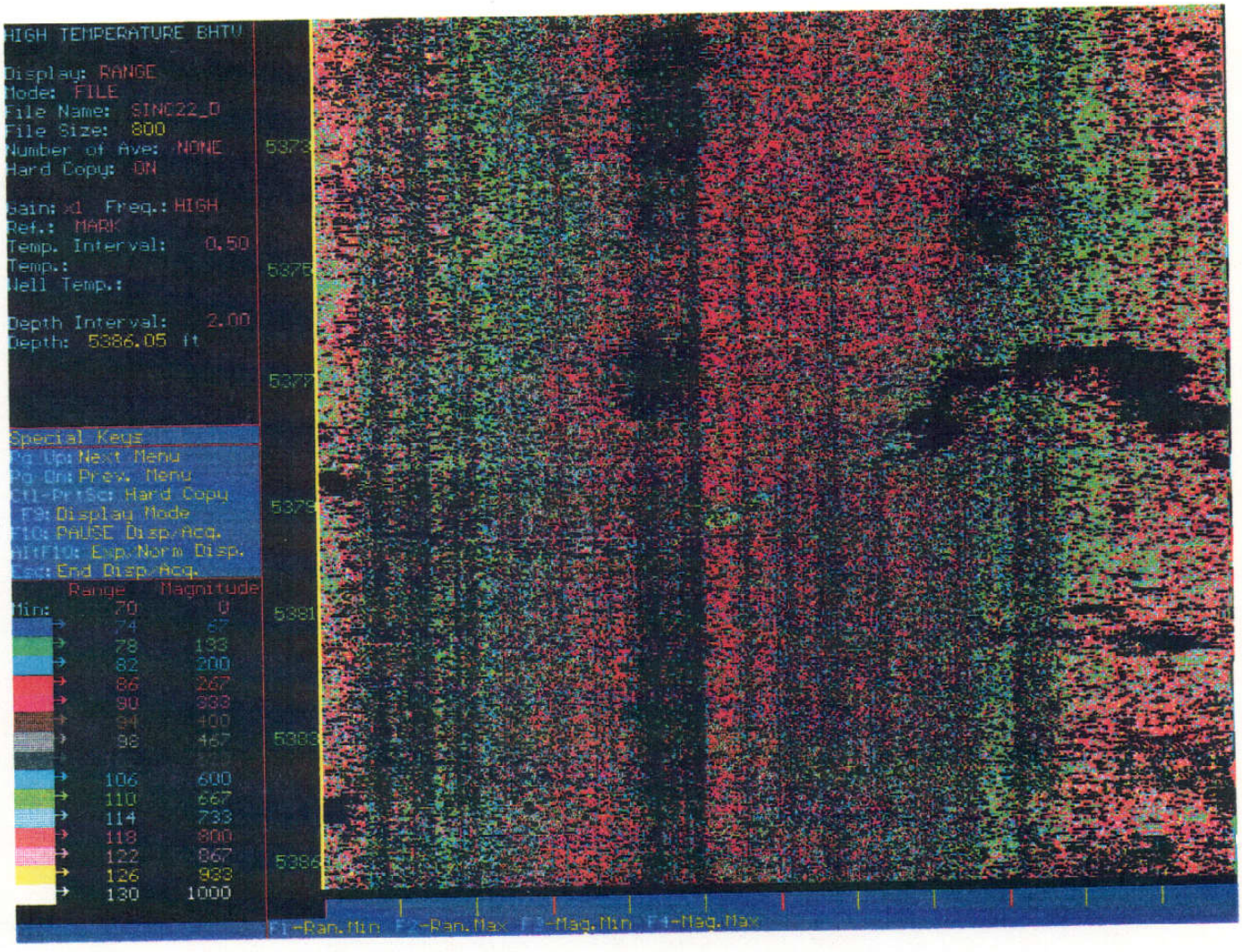


Figure IV.1. HT-BHTV data obtained during the logging of the Sinclair-22 well in the Salton Sea Geothermal area illustrating a potential fracture. The vertical stripes are due to 60 Hz noise picked up through the logging cable. The digitizer gain was set to x1; sync threshold set to -2.441 volts; range threshold set to 0.498 volts; range window set to 70 $\mu$s to 130 $\mu$s.

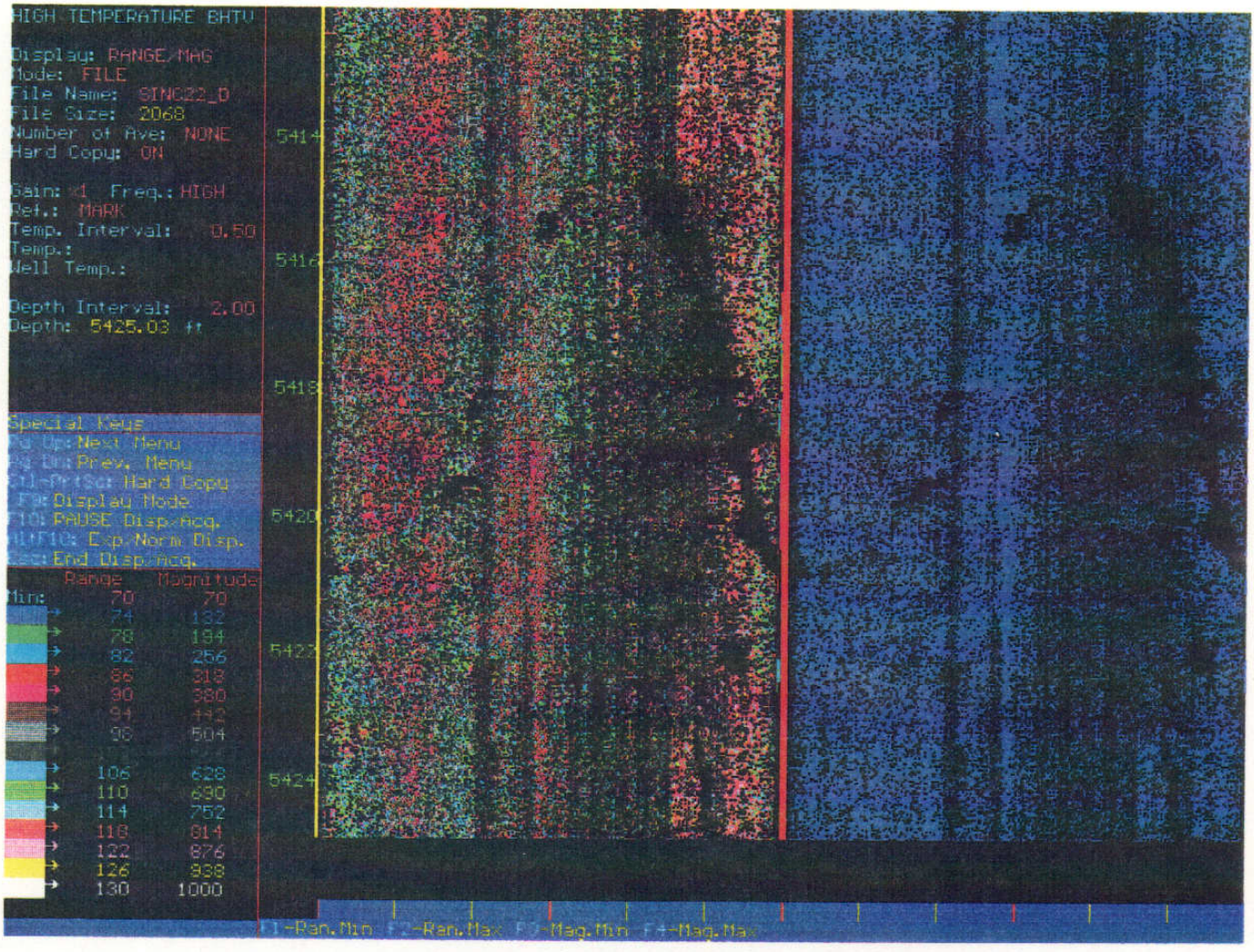


Figure IV.2. HT-BHTV data obtained during the logging of the Sinclair-22 well in the Salton Sea Geothermal area illustrating a the effect produced by changing the display window. The digitizer gain was set to xl; sync threshold set to -2.441 volts; range threshold set to 0.498 volts; range window set to 80 $\mu$s to 130 $\mu$s.

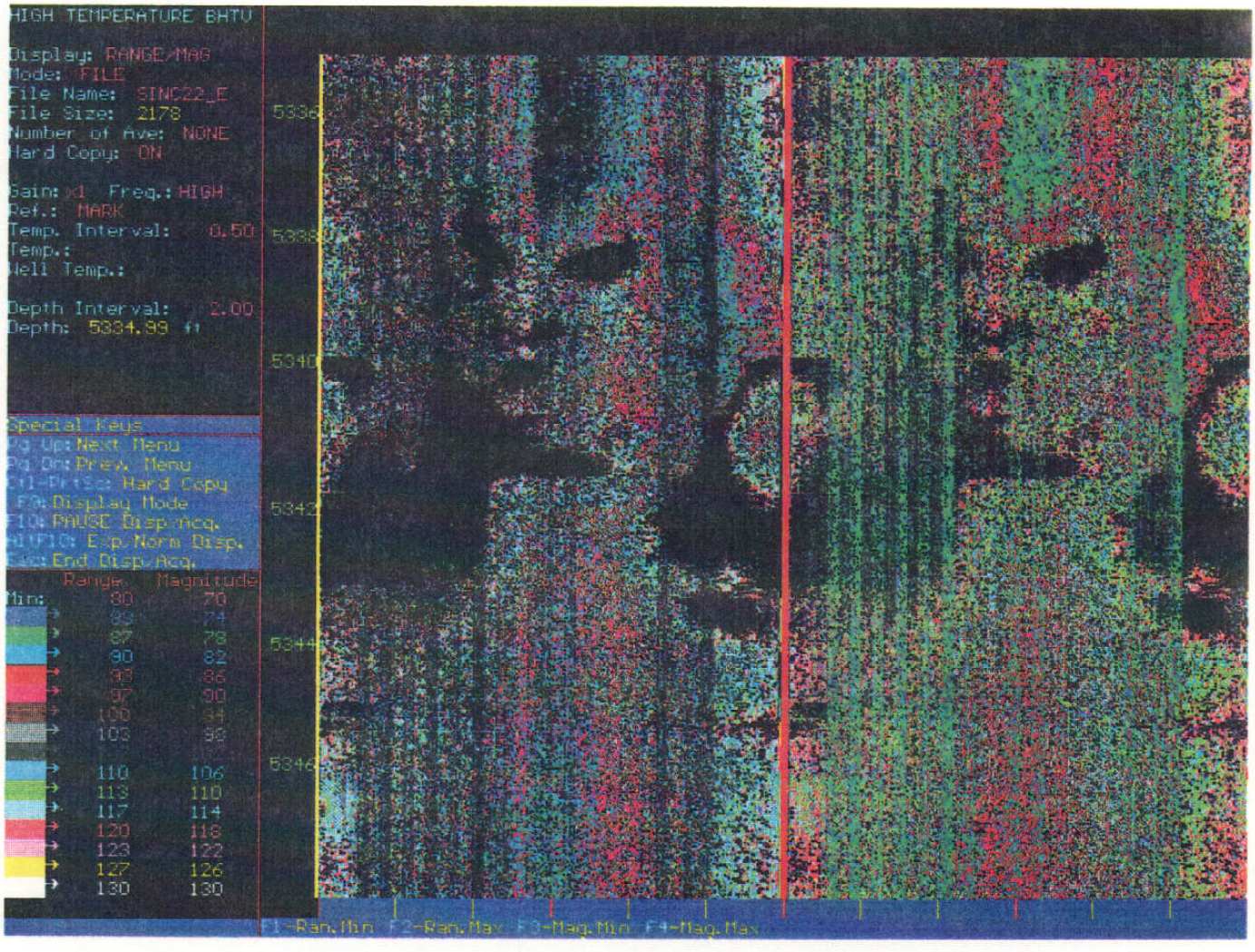


Figure IV.3. HT-BHTV data obtained during the logging of the Sinclair-22 well in the Salton Sea Geothermal area illustrating the filtering operation of the display window. The digitizer gain was set to x1; sync threshold set to -2.397 volts; range threshold set to 0.498 volts; range window set to 70 $\mu$s to 130 $\mu$s.

## V. SUGGESTIONS FOR SOFTWARE AND HARDWARE MODIFICATIONS

The software described in this User Manual has been shown to operate as desired in the field providing a *real-time* display of the televiewer data. As with any complex system, ideas for improvements always come up but are set aside because of other pressing jobs which must be done. In this section, some of those ideas which were put aside are listed for future reference in the event that modifications to the software/hardware of this system are desired. Suggested modifications to the HT-BHTV data acquisition system fall into two broad categories: software and hardware changes.

### Suggested Software Modifications

- Dual display for both the range and magnitude data. The current software can display the range, magnitude, or the range and magnitude on a split screen. It is desirable to have the capability to display either the range or the magnitude in a split screen mode so that the display window in one of the screens may be adjusted to emphasize some particular feature of the data as was demonstrated in Figures IV.2 and IV.3.

- A Help Display for each menu, describing the default settings and allowed values of each menu item, would make the program easier to use. In effect, this would eliminate the need for the User Manual when using the software.

- The software presently uses the same time window for extracting the range and amplitude data from the digitized waveform. A separate time window for the magnitude data would make the software more versatile.

- The addition of digital filtering algorithms which can operate on the data when the data are redisplayed would eliminate some of the noise in the acquired data.

- User modification of the color palette to a color scheme different from the default code would prove useful in highlighting different features in the display.

- Averaging the data lines rather than displaying all the data would provide the user with alternative methods to observe features in the televiewer data.

- The software can now only operate in the **Data-Driven** acquisition mode. The addition of the coding to allow the **Depth-Driven** acquisition mode would provide the user with a useful option when acquiring data from the tool.

- If changes occur during a logging operation that require an adjustment of the tool control or data acquisition parameters, the user has no recourse but to begin a new file. The code should be modified to allow the user to make these adjustments from the Data Acquisition/Display operation and remain in the current file. This modification requires that the software store and, in some manner, keep track of the new tool control and data acquisition parameters.

### Suggested Hardware Modifications

- Faster computers, e.g., 33 MHz rather than 20 MHz, are available. A faster computer system could allow more computations on the televiewer data.

- High capacity mass storage devices that are not unique to Compaq computers would allow more people to have access to the televiewer data. For example, high capacity WORM (Write Once Read Many) drives for IBM compatible systems are available.

- A faster digitizing board is required. The current system has a time resolution of 10 $\mu$s. New ADC boards are available which have a resolution of 1 $\mu$s. However, these boards have their own memory and do not use DMA. Additional software development is necessary to effectively use these boards in a high data rate continuous operation.

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# APPENDIX A

## Hardware Requirements of the HT_BHTV System

### Computer

Compaq Deskpro 386/20
  includes the following cards and drives:
    135 Megabyte Tape Drive
    300 Megabyte Hard Disc Drive
    2 RS-232 Serial Ports
    1 Parallel Port
    Compaq Video Graphics Controller Board
    13 Megabytes RAM

    Metrabyte DAS-20 High Performance Analog & Digital Interface Board

### Computer Peripherals

Hewlett-Packard PaintJet Color Graphics Printer
NEC Multisync Monitor

### Depth Counter

Red Lion Controls Gemini 2000 Counter with Model GCM 232 Serial Converter Module
Red Lion Controls Rotary Pulse Generator Model RGPC-46-1-0500

### Temperature Data Acquisition System

IBM PC-XT Compatible Computer with Monitor
1 RS-232 Serial Port

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College Station, TX 77843

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Roger McCann
Mobil Research &
Development Corporation
Dallas Research Center
13777 Midway Rd.
Dallas, Texas 75224

Larry Matson
Stratabit
600 Kenrick, Suite A1
Houston, TX 77060

Gene Polk
P. O. Box 280
Sandia Park, NM 87047

Steve Pye
UNOCAL Geothermal
461 S. Boylston
Los Angeles, CA 90017

Gene A. Suemnicht
UNOCAL Geothermal
3576 Unocal Place, P.O. Box 6854
Santa Rosa, CA 95406

Lawrence C. Lynnworth
Panametrics
221 Crescent Street
Waltham, MA 02254

Oren Tranbarger
Southwest Research Institute
6220 Culebra Road
San Antonio, TX 78284

Colleen Barton
Stanford University
Dept. of Geophysics
Stanford, CA 94035

George Chappell
M-W Instruments
4230 Shilling Way
Dallas, TX 75237

David Faulder
P.O. Box 1625
Mail Stop 2107
Idaho Falls, ID 83415

George P. Tennyson
DOE/ALO
P. O. Box 5400
Albuquerque, NM 87115

U. S. Dept of Energy (3)
Geothermal Technologies Div.
Attn: Lew Pratsch
Gladys Hooper
Marshall Reed
Forrestal Bldg., CE-324
1000 Independence Ave., SW
Washington, DC 20585

Sandia Internal

1512 R. D. Meyer
3141 S. A. Landenberger (5)
3141-1 C. L. Ward for DOE/OSTI (8)
3151 W. I. Klein (3)
6200 V. L. Dugan
6250 R. K. Traeger
6252 J. C. Dunn
6252 L. E. Duda (10)
6252 J. T. Finger
6252 D. A. Glowka
6252 R. D. Jacobson
6252 S. Knudsen
6252 G. E. Loeppke
6252 P. C. Lysne
6252 J. E. Uhl
6252 R. P. Wemple
6258 P. J. Hommert
9310 J. D. Plimpton
9313 S. R. Dolce
9215 M. J. Shortencarier
8524 J. R. Wackerly


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